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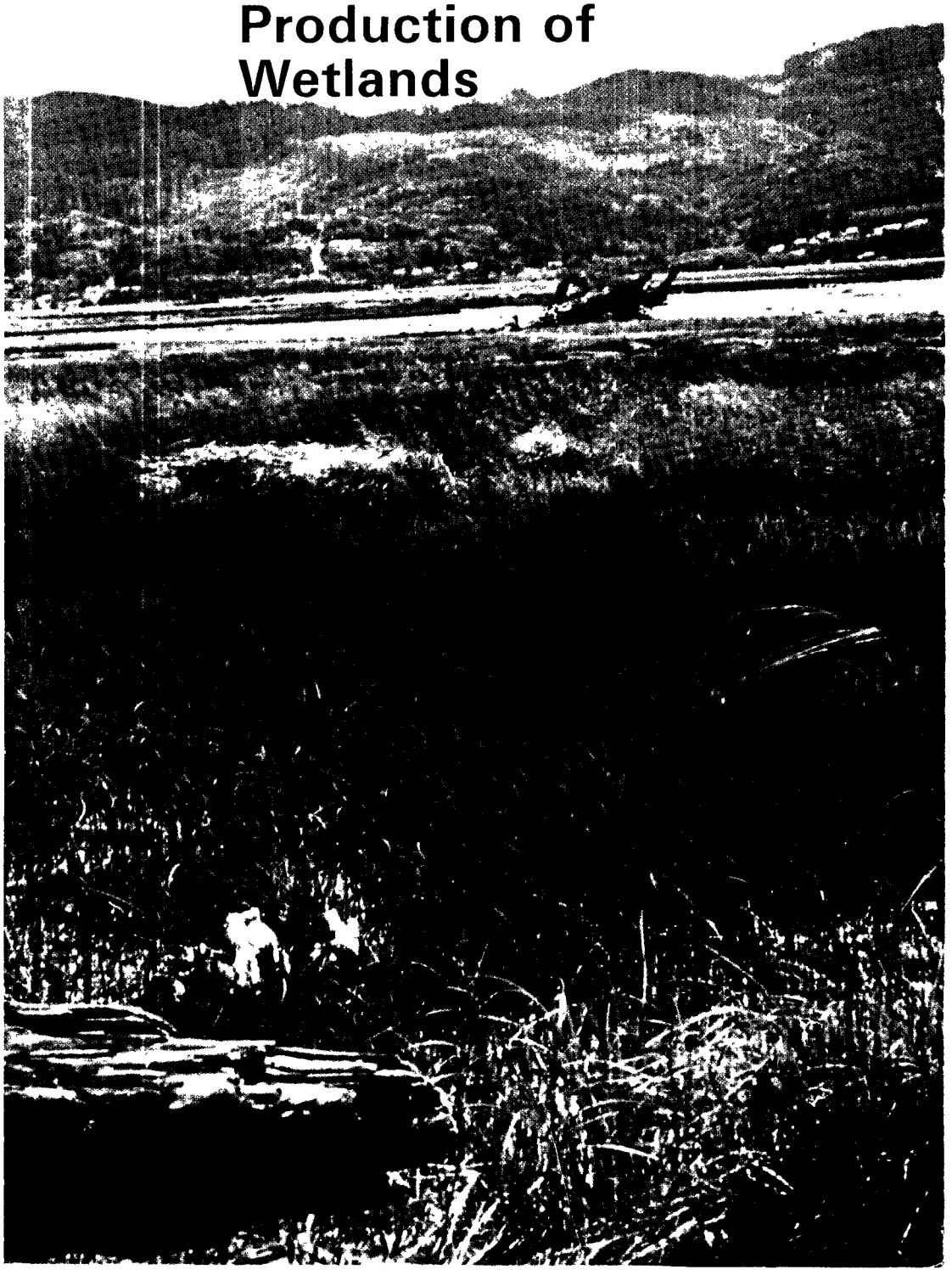
Field Guide to Evaluate Net Primary Production of Wetlands



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Field Guide to Evaluate Net Primary Production of Wetlands

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FOREWORD

Effective regulatory and enforcement actions by the Environmental Protection Agency would be virtually impossible without sound scientific data on pollutants and their impact on environmental stability and human health. Responsibility for building this data base has been assigned to EPA's Office of Research and Development and its 15 major field installations, one of which is the Corvallis Environmental Research Laboratory.

The primary mission of the Corvallis Laboratory is research on the effects of environmental pollutants on terrestrial, freshwater, and marine ecosystems; the behavior, effects and control of pollutants in lakes and streams; and the development of predictive models on the movement of pollutants in the biosphere.

This handbook presents methods for achieving a quick gross estimate of primary production in wetlands.

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Introduction

Throughout history, marshes have been considered wastelands and their destruction and elimination through reclamation projects has been lauded as progress. However, in recent decades a wide variety of ecological roles and values has been documented, and state and federal governments are acting to prevent indiscriminate destruction of these resources. Government agencies at several levels are responsible for reviewing permit applications for work or disruptions in wetland areas. By law (PL 95-217), any evaluation for work or alterations must consider all possible aspects of wetlands values. These values are often difficult to quantify, and those which can be assessed usually require extensive studies. Therefore some easily quantified parameters which reflect other functions and roles must be used for marsh evaluation. Because it forms the base of the food web, primary production is one such parameter. This field guide presents methods for *estimating* net primary production (NPP), which is defined as the amount of plant biomass that has accumulated in a given time interval. In this manual, the estimates are based on a year or the annual growing season. It must be emphasized that this guide only *aids in evaluating NPP, one of several internal and external values of the marsh.* Internal values are those which relate to the wetland itself; external values relate to the exchange between the marsh and adjacent ecosystems. Other values include:

(1) Wetlands are feeding and nursery grounds for birds, mammals and fishes. Wetland creeks are potential aquaculture sites.
(2) The water-soil-plant complex forms a nutrient processing area where important phases of the carbon, nitrogen, phosphorus and sulfur cycles take place.
(3) Wetlands are sources of organic compounds in detrital food webs.
(4) Wetlands act as metering systems, controlling output of nutrient and nonpoint source runoff to aquatic systems.
(5) Wetlands are buffers between storm-driven water and adjacent high ground and reduce shoreline erosion.
(6) Wetlands have aesthetic value as open spaces and wildlife habitats.

The field guide is divided into three sections.

Section I is a literature survey of reported maximum standing crop biomasses, arranged by species and geographical distribution based on U.S. Environmental Protection Agency Regions. Within each Region, estimates are categorized by state. Maximum standing crop biomass is often used as a *conservative* estimate of annual net primary production for herbaceous plants and is the most abundant type of data available for comparative purposes within and between regions. This information may be adequate for many routine projects.

Section II describes field procedures for estimating annual net primary production. The techniques involve a single sampling

trip where plants are examined, harvested, sorted, and weighed in the field. The field sampling results are compared to regional annual biomass cycles for that species to determine relative vigor. Annual NPP estimates for the study site are obtained by combining the relative vigor and the production reported for the site where the regional annual biomass cycle was obtained.

Section III describes the habitat of some of the plants and contains the regional annual biomass curves to be used in Section II.

The handbook has been designed to cover general situations when specific details are not needed and to describe ways to obtain detailed information when required. It helps answer the following kinds of questions:

(1) What kind of wetland is this? (Section II)
(2) What is the plant community composition? (Section II)
(3) Generally, how productive are wetlands of this type? (Section I)
(4) How does this type of wetland compare with similar types in other regions? (Section I)
(5) What is the annual net primary production of this specific marsh? (Sections II, III)

Section I.

Standing Crop Biomass

Tables 1 through 10 are arranged by EPA Region. Species or wetland types are listed on the left hand side. The first two columns of numbers are the range and mean live plant biomass at the end of the growing season (EOSL). The second two columns indicate total plant biomass at the end of the growing season (EOST), both live and dead material. The third column is the annual net primary production (NPP); the footnote indicates the source of the method used to calculate NPP. The fourth column is the reference where the data were obtained. If NPP data are not available for species at the study site, EOST or EOSL can be used as an estimate for annual net primary production. In situations where the plants die back to ground level each year and the plants are removed by decay, tidal or wind action before the end of the next growing season, EOST is generally the best estimate of annual production. Where the previous season's growth is not removed by the end of the season, EOSL may be a better conservative estimate. Since plants produce and lose leaves throughout the season, EOST or EOSL generally underestimate net primary production. Although these tables don't give the primary productivity of a specific site, they do give the person evaluating a permit application an indication of how productive that type of marsh may be in a particular region.

If the permit evaluation process requires a site-specific NPP estimate, Section II gives sampling schemes of varying complexity which are designed for short term data gathering.

TABLE 1. Standing Crop Biomass and NPP of Wetland Plants in EPA Region I.

State	Species	EOSL g/m² Range	EOSL g/m² x̄	EOST g/m² Range	EOST g/m² x̄	NPP g/m²/yr	Reference
Connecticut							
	Distichlis spicata		359		885	300[1]	62[a]
	Juncus sp.		566		851	570[1]	62[a]
	Spartina alterniflora		717 (T)		904 (T)	820[1]	62[a]
			314 (S)		525 (S)	350[1]	62[a]
					470 (S)		24
					487 (T)		62[a]
	Spartina patens		300		800		62[a]
Maine							
	Juncus gerardi		644 (T)		1694 (T)	4027[2]	57
			244 (S)		676 (S)	616[2]	57
	Spartina alterniflora		431 (T)		862 (T)	1602[2]	57
			245 (S)		886 (S)	1611[2]	57
	Spartina patens		912		3036	5833[2]	57
Massachusetts							
	Spartina alterniflora			250-420	320	510[4]	68
Rhode Island							
	Spartina alterniflora	433-1380	840				50

Footnotes are listed at the end of Table 10, page 9. See Literature Cited section for numbered references.

TABLE 2. Standing Crop Biomass and NPP of Wetland Plants in EPA Region II.

State	Species	EOSL g/m² Range	EOSL g/m² x̄	EOST g/m² Range	EOST g/m² x̄	NPP g/m²/yr	Reference
New Jersey							
	Polygonium/ Leersia		2142				76[b]
			769				21
	Nuphar advena	513-743	628			863[8]	76[b]
			529				75
	Pontederia/ Peltandra	648-677	663				76[b]
			1286				22
			594				43
			553				21
			657			650[8]	75
	Acorus culamus	623-1174	899			1071[8]	76[b]
			605				43
			819				75
	Typha sp.		987				43
			850				21
			894				22
			1297			1320	75
			1199				76[b]
			804				71

(continued)

TABLE 2. (continued)

State	Species	EOSL g/m² Range	EOSL g/m² x̄	EOST g/m² Range	EOST g/m² x̄	NPP g/m²/yr	Reference
New Jersey (continued)							
	Hibiscus palustrus		1714				76[b]
	Zizania aquatica		1390				43
		1346-2091	1744			1520[8]	76[b]
			1600				21
					1200		31
			866			1589[8]	75
	Spartina cynosuroides		3543				76[b]
	Phragmites communis	1493-3999	2746				76[b]
			1727				43
			1074				71
	Panicum virgatum		4029				76[b]
			326				13
	Scirpus sp.		802				76[b]
			472				13
			193				20
	Spartina alterniflora				1592 (T)		61
					592 (S)		61
			1003				76[b]
			725				76[c]
			587				13
			1184				76[d]
			563				30
			1172 (T)			1460[4]	72
			470 (M)			590[4]	72
			375 (S)			470[4]	72
	Spartina patens		343		724		49
			463		623		49
			449		560	4	72
	Carex stricta				1340		31
	Distichlis spicata		1390				43
	Sagittaria latifolia + *Typha angustifolia* (mix)				1380		31
	Special Fresh Water Marsh Types (NJ)						
	Cattail Marsh				1700		32
	Sedge-shrub Marsh				1350		32
	Sedge-swale Marsh				1330		32
	Open-aquatic Marsh				1200		32
New York							
	Distichlis spicata			523- 774	648		67
			565		985		48[a]
	Phragmites communis				2686		25
	Scirpus sp.		786				37
	Spartina alterniflora			669-1118	872 (T)		67
				341- 660	580 (S)		67
	Spartina patens			424- 546	503		67
					993		25
	Typha angustifolia				1728		25

(continued)

TABLE 2. (continued)

State	Species	EOSL g/m² Range	EOSL g/m² x̄	EOST g/m² Range	EOST g/m² x̄	NPP g/m²/yr	Reference
New York (continued)							
	Typha latifolia				1357		25
	Carex lacustris					965[8]	6
						857[8]	
						(1580)[8]	5
						540[8]	
	Carex rostrata					(823)[8]	4[e]

Footnotes are listed at the end of Table 10, page 9 See Literature Cited section for numbered references

TABLE 3. Standing Crop Biomass and NPP of Wetland Plants in EPA Region III.

State	Species	EOSL g/m² Range	EOSL g/m² x̄	EOST g/m² Range	EOST g/m² x̄	NPP g/m²/yr	Reference
Delaware							
	Spartina Alterniflora		305		572		48
							30
	Spartina patens		962		1924	2753[2]	57
	Distichlis spicata		1142		2444	2017[2]	57
	Juncus gerardi		560		1308	1540[2]	57
	Phragmites communis		965		4016	1749[2]	57
Maryland							
	Spartina alterniflora		468			457[1]	11[a]
					1207		33
	Spartina cynosuroides		1170				2
			951		1192		15
			1207			1572[8]	33
	Scirpus americanus		204				2
	Panicum virgatum		480				2
	Juncus roemerianus		1082				27
	Phragmites communis		1367		1714		15
			1451			1678[8]	33
	Zizania aquatica		1178		1313		15
	Typha sp		2338		2505		28
			966			1868[8]	33
			1190		1520		15
Maryland-Virginia							
	Spartina alterniflora		558 (S)		800 (S)		34
			427 (ST)		924 (ST)		34
Pennsylvania							
	Distichlis spicata		1117				42
	Phragmites communis		654				42
	Bidens sp.		900				42
	Lythrum salacaria		1373				42

(continued)

TABLE 3. (continued)

State	Species	EOSL g/m² Range	EOSL g/m² x̄	EOST g/m² Range	EOST g/m² x̄	NPP g/m²/yr	Reference
Virginia							
	Spartina alterniflora				1570 (T)		73
					695 (M)		73
			363		459		45
						362[8]	46
	Spartina patens				805		73
	Spartina cynosuroides		546		998	563[2]	45[a]
					1456		73
	Distichlis spicata				360		73
	Juncus roemerianus				650		73
	Zizania aquatica				560		73
	Leersia oryzoides				1545		73
	Nuphar advena				245		73
	Typha angustifolia				930		73
Mixes							
	Spartina cynosuroides *Spartina alterniflora* *Juncus* sp.		500		850	563[8]	46
	Polygonum/Leersia *Spartina alterniflora*		523				42
	Spartina patens *Distichlis spicata*		450		800	572[8]	42

Footnotes are listed at the end of Table 10, page 9. See Literature Cited section for numbered references.

TABLE 4. Standing Crop Biomass and NPP of Wetland Plants in EPA Region IV.

State	Species	EOSL g/m² Range	EOSL g/m² x̄	EOST g/m² Range	EOST g/m² x̄	NPP g/m²/yr	Reference
Alabama							
	Justicia americana		640				7
	Alternanthera philoxeroides		841				7
Georgia							
	Spartina alterniflora		3108 (T)		3315 (T)	3990[8]	51
			2018 (S)		2182 (S)	2362[8]	51
			1300 (T)				56
			310 (S)				56
	Spartina patens		980		2304	3925[2]	57
	Spartina cynosuroides	515-1242	826	825-2092	1175	2092[7]	51
			2176		4760	6039[2]	57
	Distichlis spicata		246		603		19
			458		1718	4378[2]	57
	Juncus sp.		913		1538		19
			1300			2261[2]	56
	Sporobolus virginicus		262		578	1387[2]	57

(continued)

TABLE 4. (continued)

State	Species	EOSL g/m^2 Range	EOSL g/m^2 $\bar{x}$	EOST g/m^2 Range	EOST g/m^2 $\bar{x}$	NPP g/m^2/yr	Reference
Florida							
	Spartina alterniflora	593-824	702				66
	Juncus sp.		232		849		26
Mississippi							
	Spartina cynosuroides					2190[3]	12
	Spartina alterniflora					1964[3] (T)	12
						1089[3] (S)	12
	Phragmites communis					2330[3]	12
	Scirpus robustus					1056[3]	12
	Juncus roemerianus					1697[3]	12
	Spartina patens					1922[3]	12
	Distichlis spicata					1484[3]	12
	Sagittaria lancifolia					600[3]	12
	Community Mix:						
	Juncus roemerianus		675			390[3]	17
	Spartina cynosuroides		387			475[3]	17
	Scirpus americanus		60			77[3]	17
	Distichlis spicata		45			63[3]	17
	Other		47			46[3]	17
	Community Total		1214			1051	17
North Carolina							
	Spartina alterniflora		1319 (T)		1752 (T)	1296[1]	63
			295 (S)		455 (S)	329[1]	63
			1550 (T)		2200 (T)		77
			400 (S)		1100 (S)		77
			401 (S)		790 (S)	370[6]	39
			680 (M)		1080 (M)	610[6]	39
			1450 (T)		2050 (T)	1300[6]	39
	Spartina patens		559		1555	1453[1]	70
			720		898	406[1]	70
	Juncus sp.	520-1173	804	1515-2088	1756	796[1]	63
		117-405	234	477-1215	828		16[a]
		476-1106	743	1905-3286	2452	754	78
		329-806	605	1216-2445	1875	895[1]	70
South Carolina							
	Typha latifolia		680				8
	Scirpus americanus		145				8

Footnotes are listed at the end of Table 10, page 9 See Literature Cited section for numbered references.

TABLE 5. Standing Crop Biomass and NPP of Wetland Plants in EPA Region V.

State	Species	EOSL g/m² Range	EOSL g/m² x̄	EOST g/m² Range	EOST g/m² x̄	NPP g/m²/yr	Reference
Minnesota							
	Carex rostrata		852			738[8]	3
	Typha sp.				1360		9
					1680		10
	Zizania aquatica				500		10
Michigan							
	Glyceria striata	30-45	37				52

Footnotes are listed at the end of Table 10, page 9. See Literature Cited section for numbered references

TABLE 6. Standing Crop Biomass and NPP of Wetland Plants in EPA Region VI.

State	Species	EOSL g/m² Range	EOSL g/m² x̄	EOST g/m² Range	EOST g/m² x̄	NPP g/m²/yr	Reference
Louisiana							
	Spartina alterniflora		1018 (T)		1960 (T)	2645[2]	35
						1409[1]	
			782 (S)		1544 (S)	1323[8]	35
						1005[1]	
			1018 (T)		1948 (T)	2645[2]	36
			788 (S)		1488 (S)	1323[2]	36
			754				23
			1056		1944		1
	Spartina patens		895		1685	2128[1]	53
			1376				23
	Spartina cynosuroides		808				23
	Sagittaria falcata		648				23
	Eichornia crassipes				1478		55
					1276		54
	Distichlis spicata		991				23
	Juncus roemerianus		1240				23
	Phragmites communis		990				23
Oklahoma							
	Typha latifolia		1527				54
	Typha sp.				730		44
Texas							
	Spartina alterniflora	382-938	745	583-1846	1333		66
	Typha sp.				1336		44

Footnotes are listed at the end of Table 10, page 9. See Literature Cited section for numbered references

TABLE 7. Standing Crop Biomass and NPP of Wetland Plants in EPA Region VII.

State	Species	EOSL g/m^2 Range	EOSL g/m^2 $\bar{x}$	EOST g/m^2 Range	EOST g/m^2 $\bar{x}$	NPP g/m^2/yr	Reference
Iowa							
	Typha glauca	758-2106	1314			2297[5]	69
	Phragmites communis	777-1110	943				69
	Scirpus acutus	751-951	851				69
	Carex spp.	523-2231	927			2858[5]	69
	Sparganium eurycarpum	474-1054	721			1066[5]	69
	Scirpus fluviatilis	450-791	547			943[5]	69
	Sagittaria latifolia		460				69
	Scirpus validus	243-602	398			713[5]	69
	Bidens cernua		598				69
Nebraska							
	Typha spp.				416		44

Footnotes are listed at the end of Table 10, page 9. See Literature Cited section for numbered references.

TABLE 8. Standing Crop Biomass and NPP of Wetland Plants in EPA Region VIII.

State	Species	EOSL g/m^2 Range	EOSL g/m^2 $\bar{x}$	EOST g/m^2 Range	EOST g/m^2 $\bar{x}$	NPP g/m^2/yr	Reference
North Dakota							
	Typha latifolia				404		44
South Dakota							
	Typha spp.				378		44

Footnotes are listed at the end of Table 10, page 9. See Literature Cited section for numbered references

TABLE 9. Standing Crop Biomass and NPP of Wetland Plants in EPA Region IX.

State	Species	EOSL g/m^2 Range	EOSL g/m^2 $\bar{x}$	EOST g/m^2 Range	EOST g/m^2 $\bar{x}$	NPP g/m^2/yr	Reference
California							
	Spartina foliosa	137-513	325				38
		1173-1245	1209				38

Footnotes are listed at the end of Table 10, page 9 See Literature Cited section for numbered references.

TABLE 10. Standing Crop Biomass and NPP of Wetland Plants in EPA Region X.

State	Species	EOSL g/m² Range	EOSL g/m² $\bar{x}$	EOST g/m² Range	EOST g/m² $\bar{x}$	NPP g/m²/yr	Reference
Oregon							
	Carex sp.				1113 (T)		29
					834 (S)		29
	C. lyngbyei		1169				14
						1849[2] (T)	-[f]
					206		29
	Triglochin maritimum		527		184		29
						896[2]	-[f]
	Scirpus americanus		351				14
						549[2]	-[f]
	Juncus balticus					453[2]	-[f]
			734				14
	Deschampsia caespitosa				106		29
			372				14
	Distichlis spicata					1300[2]	-[f]
	Potentilla pacifica					896[2]	-[f]
	Scirpus validus				795		29
	Salicornia virginica					1644[2]	-[f]
					184		29
Alaska							
	Carex aquatilis				25.5		64

[a] As reported in Turner, 1976
[b] Unpublished data attributed to J. McCormick
[c] Unpublished data attributed to R. E. Good and R Walker
[d] Unpublished data attributed to G. T. Potera and E. E. McNamara
[e] Unpublished data attributed to Bernard and Hankinson
[f] Unpublished data attributed to Gallagher and Kibby

Technique
[1] Smalley, 1959
[2] Weigart and Evans, 1964
[3] Milner and Hughes, 1968
[4] Williams and Murdoch, 1969
[5] Mason and Bryant, 1975
[6] Maximum - Minimum
[7] EOST
[8] Other - method not stated

Growth form
T - Tall form (creek bank)
S - Short form (High marsh)
ST - Short and Tall mix
M - Medium height

Section II

Estimating Primary Production Using Field Sampling

The method selected to estimate the primary production of a wetland will depend on the type of marsh, the size and location of the project area, social and political considerations, and available resources (time and money). This section of the handbook is divided into two subsections: Section A provides methods for estimating production of a monospecific stand and Section B presents methods for estimating production of mixed species stands. These methods are to be used only for quick estimates on relatively small projects when time and resources prohibit in-depth analyses.

A. Net Primary Production Estimate for a Monospecific Stand

If the site is monospecific, i.e. occupied by a single plant species, production may be estimated with the following procedure. Select an area which appears typical of the marsh. Throw a marker (quadrat frame, bright cloth tied to a weight, etc.) back over your shoulder. This marks the center of the plot, or quadrat, you will harvest. The plot size will depend on the plant species and the nature of the community. Quadrat frames between 0.1 and 1.0 m^2 should suffice for most species. The more dense the plant stand and the more uniform the stem distribution, the smaller the quadrat can be. Cut all of the attached plant material with scissors or pruning shears (depending on plant texture) at the soil surface within the frame. Separate into living and dead material and separately weigh the total of each to the nearest 10 grams. Living plants are identified as those which have some parts containing chlorophyll. It is important to examine the material closely so that all workers separate live and dead material consistently. If possible, the dead material should be only of the current year's growth. If it is obviously from a previous year do not include it in the totals. Collect at least seven samples from

different locations within the site. Samples should be weighed to the nearest 10 grams, using a simple field balance. If your initial sampling gives results where the standard deviation is equal to or greater than 40% of the mean, increase the number of plots harvested. Continue sampling until you feel you have adequately characterized the living and total biomass in the marsh.

If sampling coincides with the end of the growing season, you can use either the EOST or EOSL as a conservative estimate of net primary production. See example in Box A-1.

If it is necessary to sample monospecific stands at a time other than the end of the growing season, a different approach is required. The procedure is based on two assumptions: (1) the annual biomass curve at the project site and the intensively studied marsh reported in the literature are parallel, and (2) the annual primary production is proportional to the biomass for a given type of plant stand. For example, it is assumed that the annual biomass curves for two stands of high marsh *Carex lyngbyei* located within a few degrees of the same latitude are similar in shape, although not necessarily equal in magnitude. In actuality, soil nutrients or salinity may be more favorable at one site and thus influence the vigor of the stand. The second assumption that the curves are parallel is probably not entirely valid. However, when evaluating permit applications, there is seldom

Box A-1

Net Primary Production Estimate for a Monospecific Stand Sampled at the End of the Growing Season.

The project site was 2 ha of high marsh *Carex lyngbyei* in Willapa Bay, WA. On 4 September, seven 0.5 m^2 plots were cut and the total and live material weighed. The average total weight was 1200g; 800g was living and 400g was dead material. Appendix A gives the percent dry weight for selected species. From this appendix it can be determined that the dry weight of live and dead biomass is approximately 25% and 40% of the wet weight, respectively. Therefore, the dry weight of the sample was

Live: 800g x 0.25 = 200g
Dead: 400g x 0.40 = 160g
360g - Total dry weight of sample.

Since the sample was taken with a 0.5 m^2 quadrat, the dry weight biomass per square meter is 360g x 2 = 720 g/m^2. This estimate of EOST is probably a reasonable estimate of annual NPP.

time for long-term intensive studies. The proposed procedures provide the best results for available time and money. The example in Box A-2 illustrates the method.

Box A-2

Net Primary Production Estimate for a Monospecific Stand Sampled Anytime During the Year.

The project involves 2 ha of high marsh *Carex lyngbyei* in Willapa Bay, WA. On 10 June, seven 0.25 m^2 plots were cut and the live material weighed. The wet weights in grams were: 350, 460, 500, 450, 400, 470, and 400; the average is approximately 430 g/0.25m^2 or 1720 g/m^2. Section III contains detailed *Carex* biomass curves for several geographical locations. The one closest to the sampling location, the Oregon coast, was selected. Appendix A gives the percent dry weight of living material for *Carex* at 25%. Therefore in this example, the average 1720g wet weight/m^2 yields a dry weight of 430 g/m^2. The graph also shows that the June biomass for the intensively studied stand was 1050g dry wt/m^2. The annual NPP for the marsh where the biomass curve was determined was 1850g dry wt/m^2/yr. The biomass at sampling time in Willapa Bay was 430 g/m^2, therefore the ratio between the project site in Willapa Bay and the intensively studied site in Oregon is 430/1050 = 0.41. Assuming the NPPs are similarly related, the NPP of the Willapa Bay marsh is estimated to be 0.41 x 1850 or 760 g/m^2/yr. Thus, for permit evaluation purposes, the production of the marsh is approximately 760g dry wt/m^2/year. This value can then be compared to the *Carex* values given in the tables in Section 1.

(1) Date: 10 June (2) Quadrat Size: 0.25 m^2
(3) Site Location: Willapa Bay, WA
(4) Predominant Species — *Carex*
(5) Live weight biomass per quadrat, in grams
  a. 350 d. 450 g. 400
  b. 460 e. 400
  c. 500 f. 470
(6) Average live biomass — 430g
(7) Factor to convert to g/m^2 = 4
(8) Live biomass per m^2 (6) x (7) = 1720g
(9) Dry wt/m^2 of sample = 430g
  (From Appendix A)
(10) Ratio of dry weight in sample to intensively studied plot biomass = 0.41
  (From appropriate graph Section III)
(11) Estimated NPP = (10) x NPP for intensively studied site:
  0.41 x 1850 = 760g dry weight/m^2/yr.

B. Net Primary Production estimates for mixed species stands.

Although wetlands in some areas of the country are large monospecific stands, often they are diverse communities. Some have a uniform species mixture while others have a clumped distribution. In both instances, the recommended NPP procedure is to determine the species composition and sum the production of each species to obtain the total for the project area. Community composition estimation methods depend on the species distribution.

If the distribution is such that seven randomly placed 0.1 m^2 plots give a consistent percent biomass composition, use the technique described in Box B-1. This method can also be used if the wetland consists of zones of uniformly mixed communities.

Box B-1

Net Primary Production Estimate for a Uniformly Mixed Community

The project involved the analysis of a 1 ha uniformly mixed community of *Distichilis spicata* and *Salicornia virginica* in southwestern Oregon. Live material from seven 0.1 m^2 random plots were harvested on 15 June and the plants sorted into species. The average fresh weight for each species was determined. The live weight of *D. spicata* was 200g and that of *S. virginica* was 450g. Using Appendix A to convert from wet to dry weight, the dry weights were determined to be 90 and 140 g/m^2, respectively. The percent contribution of each species was calculated from the total dry biomass, i.e., 90/230 x 100 = 40% for *D. spicata* and 140/230 x 100 = 60% for *S. virginica.* With these results, the community can be described as a 40:60 mixture of *D. spicata* and *S virginica.*

The biomass dry weights are used to determine annual NPP in the same manner as Box A-2. The appropriate month and the closest geographical standard curve are used to determine the annual NPP for each species. The final result is

Box B-1 (continued)

the sum of the two species calculated independently. For this example, *D. spicata* is estimated to produce 270g dry wt/m²/yr and *S. virginica* 210g dry wt/m²/yr. The annual NPP estimate for the combined community is 480g dry wt/m²/yr.

(1) Date: 15 June (2) Quadrat Size: 0.1 m²
(3) Site Location: Southern Oregon
(4) Predominant Species: (A) *Distichlis spicata;*
(B) *Salicornia virginica*
(5) Live weight biomass per quadrat, in grams—Species A
a. 17 d. 24 g. 16
b. 21 e. 19
c. 20 f. 23
(6) Average Live Biomass — Species A = 200g/m²
(7) Dry weight Species A (From Appendix A) = 90g
(8) Live weight biomass per quadrat, in grams—Species B
a. 50 d. 42 g. 45
b. 48 e. 43
c. 40 f. 47
(9) Average live biomass — Species B = 450g/m²
(10) Dry weight Species B (From Appendix A) = 140g
(11) Total dry weight (7 + 10) = 90 + 140 = 230g
(12) % contribution of each species:
A = (7) ÷ (11) x 100 = 90 ÷ 230 x 100 = 40%
B = (10) ÷ (11) x 100 = 140 ÷ 230 x 100 = 60%
(13) NPP for each species
(A) do as in Box A-2 — 270g
(B) do as in Box A-2 — 210g
(14) Annual NPP = (13A + 13B)
270g + 210g = 480g dry weight/m²/yr.

A fourth example is where the plants within the community have a clumped rather than a uniform distribution. In this case larger plots are necessary for representative sampling of the wetlands, but harvesting such plots, which might be as large as 25 m², is impractical.

The recommended approach is to stake out plots. The size depends on the plant distribution; plots should be large enough to provide a representative sample of the site. Visually estimate the percent bare soil and the percent covered by each species. At least four plots should be examined. Estimate the production of each species as in Box A-2 and sum the results. An example of this technique is given in Box B-2.

Box B-2.

Net Primary Production Estimates for Clumped Community Distribution.

The area was adjacent to that described in Box B-1 and covered 4 ha. Four square 36 m^2 plots were "randomly" located, staked out, and delineated with a cord. Each plot was divided into quarters, and estimates of the percent species cover and percent bare ground were made on each quarter and the values averaged.

(1) Date: 15 June (2) Plot Size: 36 m^2
(3) Site Location: Southern Oregon
(4) Predominant Species: (A) *Distichlis spicata*
(B) *Salicornia virginica*
(C) *Triglochin maritima*
(5) Plot 1: Percent Cover

	Species A *Distichlis spicata*	Species B *Salicornia virginica*	Species C *Triglochin maritima*	Bare Ground
Quarter 1	50	40	10	0
2	20	60	0	20
3	30	40	20	10
4	30	70	0	0
$\bar{X}$	32%	52%	8%	8%

Seven samples were then harvested from the vegetated areas and annual NPP computed. In this study, *D. spicata* and *S. virginica* were growing in a mixed stand (as in Box B-1 example).
(6) NPP of the uniformly mixed species

Species	Mean Live Weight (g)	Dry Weight (g)	Annual NPP ($g/m^2/yr$)
D. spicata	200	90	270
S. virginica	450	140	210

(7) Contribution of Species A and B to the total community NPP
Species A (270) + Species B (210) = Total (480 g) x % Cover (84%) = 400 g
Triglochin maritima occurred in monospecific patches and the production was calculated as in Box A-2. *Triglochin* contribution (as determined with the Box A-2 method) was 300g dry $wt/m^2/yr$. The bare ground was also located as patches and obviously had no macrophyte productivity.

Box B-2 (Continued)

All these data were combined in the following table to estimate NPP for the whole plot.

Species or mixtures	Annual NPP ($g/m^2/yr$)	% of total area covered	Weighted Production (g dry $wt/m^2/yr$)
D. spicata, S. virginica	480	84	400
T. maritima	300	8	20
Bare Ground	—	8	—
Community Annual NPP			420

The annual NPP of Plots 2, 3, and 4 were determined by the above method to be 800, 600, and 1000 $g/m^2/yr$ respectively; therefore, annual NPP from Plot 1 + Plot 2 + Plot 3 + Plot 4 ÷ Number of plots sampled = 700 $g/m^2/yr$ NPP for the community.

Integrated primary production value for the study site.

For more complex projects, aerial photographs which are available from various private, state and federal agencies may be used to integrate primary production values over a large area. The U.S. Soil Conservation Service, local tax collection agencies and planning agencies are often good sources of high quality vertical photographs. The U.S. Fish and Wildlife Service, National Wetlands Inventory, has compiled an atlas of existing wetland aerial photography for the United States.[1] In the absence of large scale aerial photography, Orthophoto-quads (1:10,000) may be of use. Regardless of the type of base map, the texture and/or color patterns can be used in conjunction with a thorough on-site inspection to produce a vegetation map. The map may be drawn directly on the photograph and the total area of the site and the component plant stands measured.

A number of satisfactory methods can be used to measure areas. If a coordinographic table is not available, a compensating polar planimeter can be used. In the absence of these, the photograph or overlay may be cut into pieces conforming to the species distribution pattern. The pieces of paper representing the areas of the same species can be grouped and weighed. These weights can be compared to the weight of a known area of paper. Another simple and effective method is the dot grid overlay system often used by foresters. A series of acetate sheets with various densities of dot patterns are sequentially placed over the map and the number of dots in each floristic unit counted. Since each dot is centered in a certain size area, the number of dots in each floristic type is multiplied by the area represented by each dot. This gives the area occupied by each type. The dot density necessary to give accurate results depends on the vegetation pattern. Using a series of different dot grid densities will enable the researcher to select the density which gives the most accurate answer while minimizing the time necessary to count dots.

The procedures presented in this section provide the wetlands evaluator with a series of options to use when it is necessary to make an on-site evaluation of the annual NPP of the marshland.

[1]Index available from National Wetlands Inventory, Suite 217, Date Bldg , 9620 Executive Center Drive, St Petersburg, Florida 33072

Section III

Plant Habitats and Annual Biomass Graphs

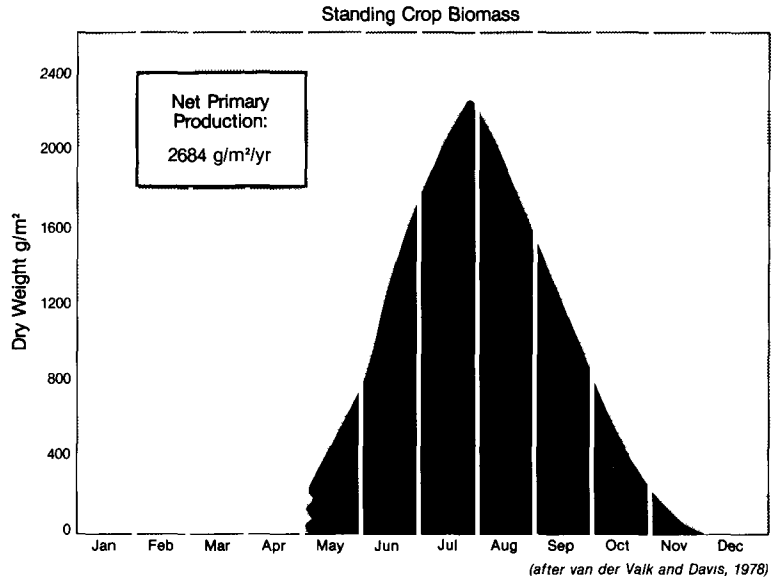
This section in the handbook describes the habitat of some of the plants. *American Wildlife and Plants: A Guide to Wildlife Food Habits* by Martin, Zim and Nelson, and *Tidal Wetland Plants of Virginia* by Silberhorn are the basic references. Annual biomass curves and net primary production values are given for those species where data are available. Where no source is noted, curves are based on data from our work at EPA's research laboratory in Corvallis, Oregon.

CAREX
SEDGES

While there are numerous species of the genus *Carex* in the United States, many grow under moist upland conditions. The only true wetland species for which production data are available is *Carex lyngbyei* (Lyngbye's sedge). This species occurs from Alaska to California and from Greenland to Maine. It forms large monospecific stands on intertidal low saline marshes. The upper distribution limit is approximately the mean lower high tide on the West Coast. It appears to have extensive interactions with adjacent estuaries. *Carex obnupta* or slough sedge is a common West Coast species that grows near the marsh upper limit. Other common species are *C. atherodes, C. lacustris,* and *C. rostrata.*

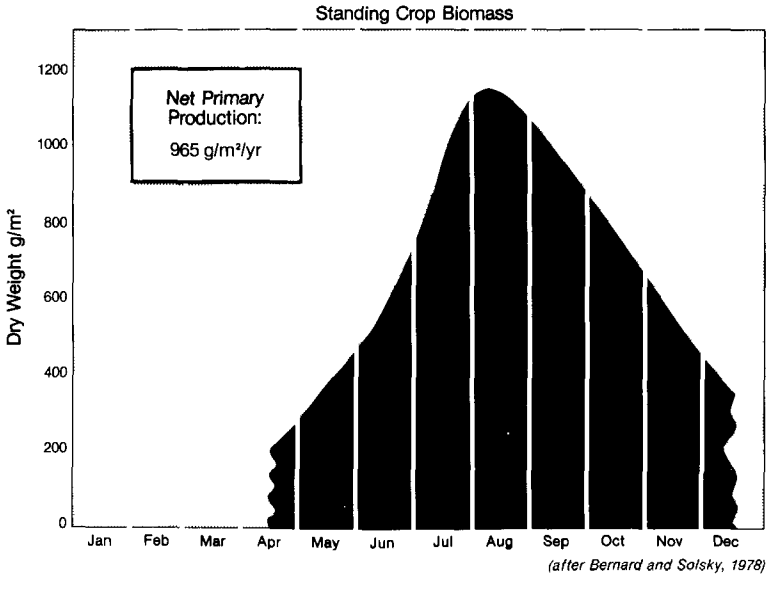
C. lyngbyei

Carex atherodes — Iowa

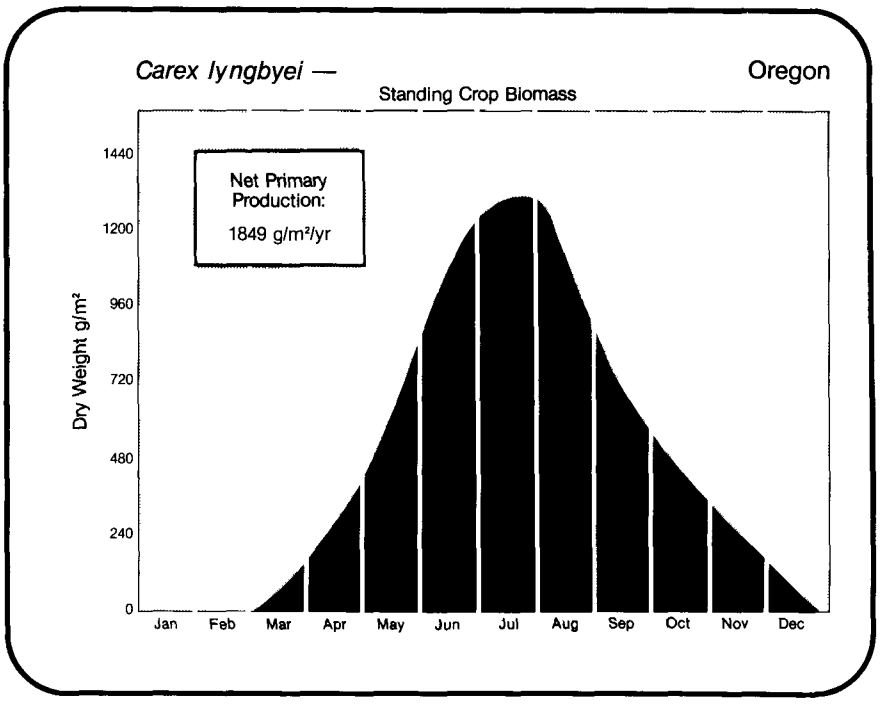


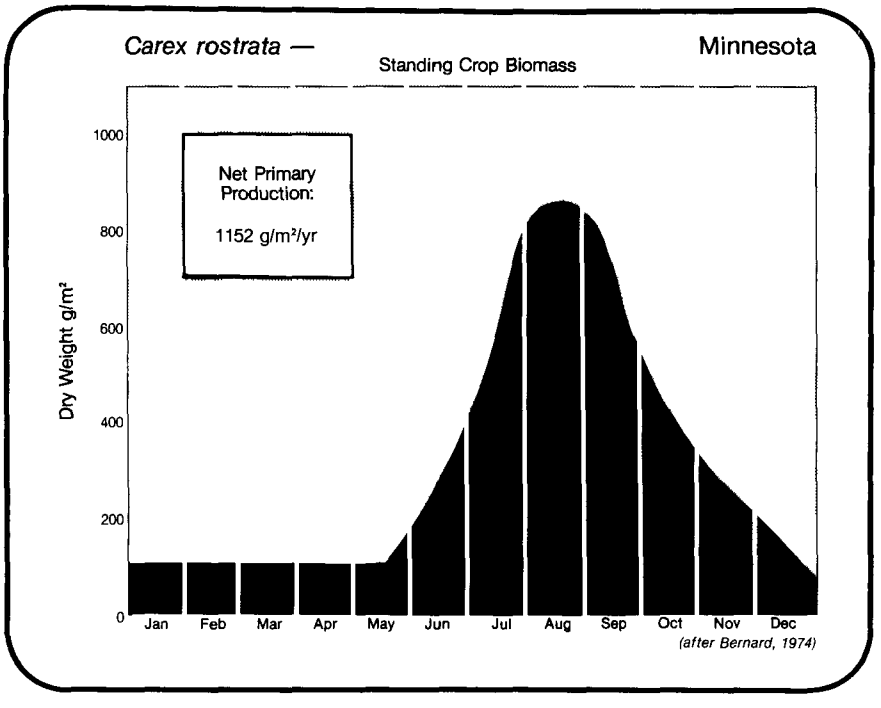
(after van der Valk and Davis, 1978)

Carex lacustris — New York



(after Bernard and Solsky, 1978)

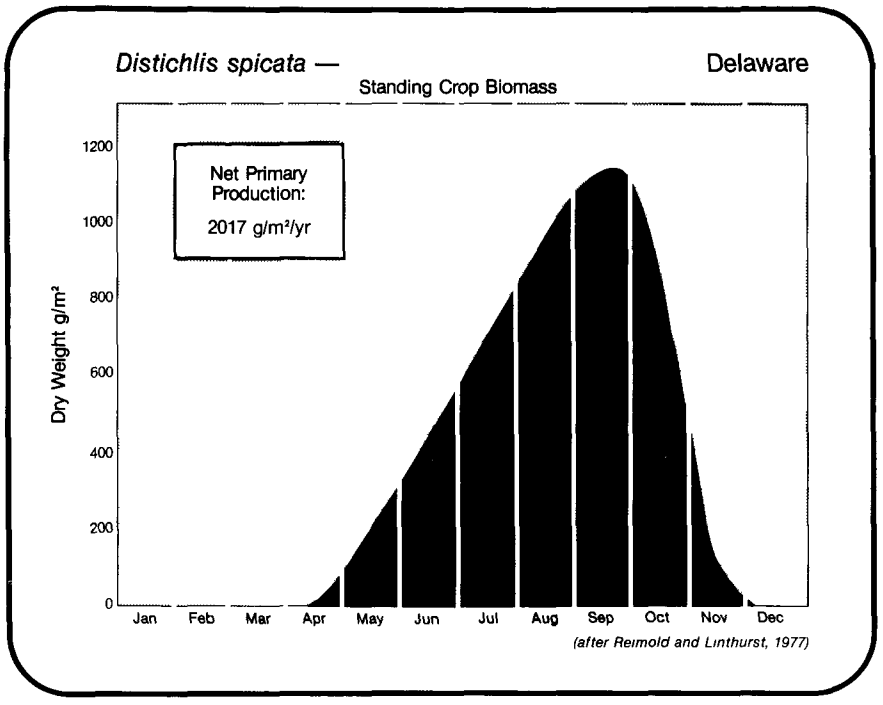

Carex lyngbyei —
Oregon
Standing Crop Biomass
Net Primary Production:
1849 g/m²/yr
Dry Weight g/m²
1440
1200
960
720
480
240
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

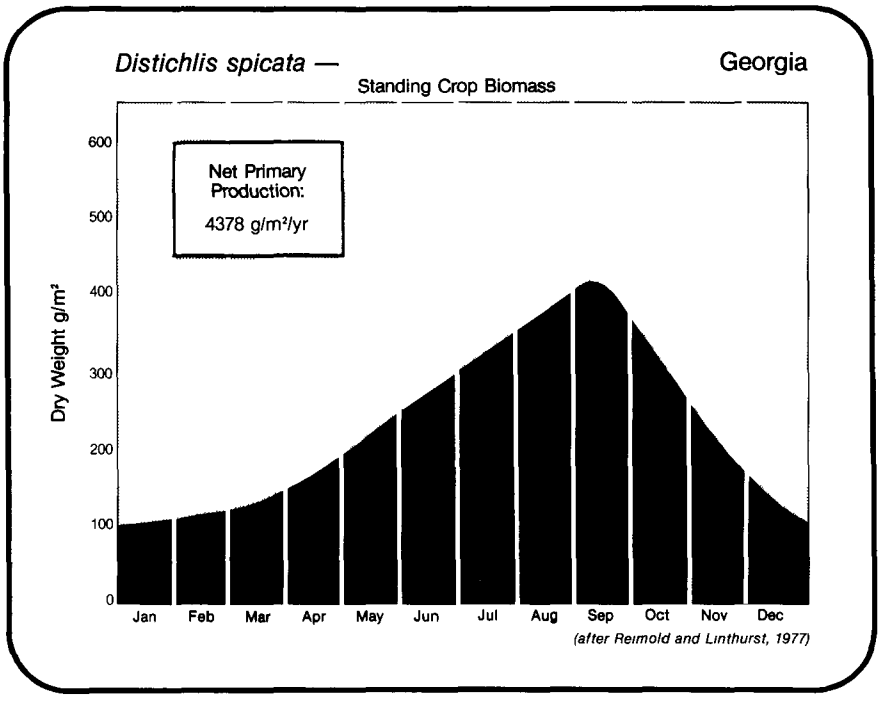

Carex rostrata —
Minnesota
Standing Crop Biomass
Net Primary Production:
1152 g/m²/yr
Dry Weight g/m²
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Bernard, 1974)

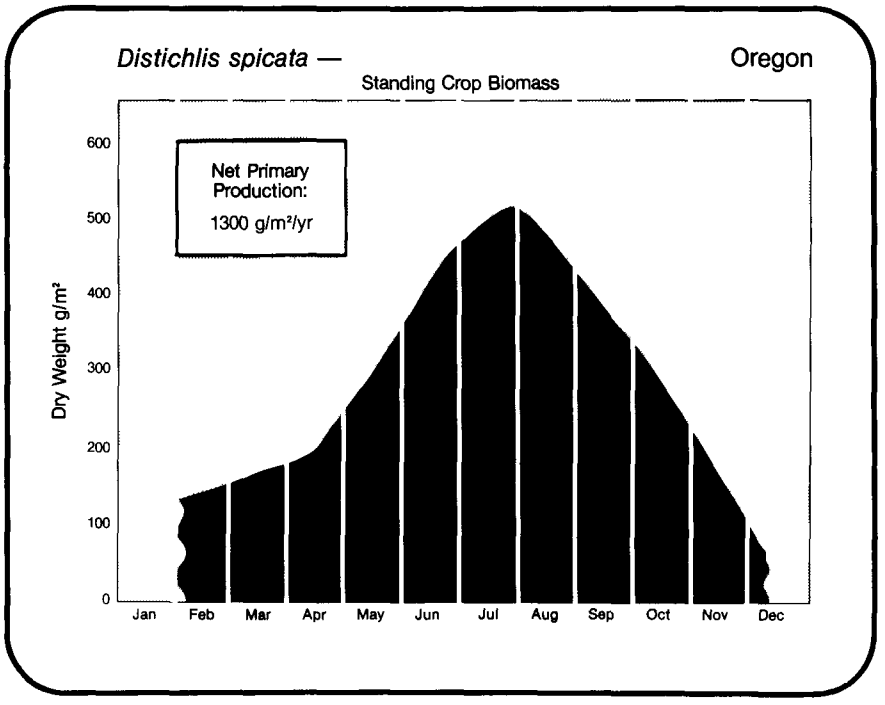
DISTICHLIS
SALTGRASS

Distichlis spicata or coastal saltgrass is generally an intertidal species, although it is occasionally found well above the wetland boundry. The distribution is limited to saline soils along all three coasts. A closely related species, *D. striata*, occurs in saline inland areas of the west. On the East Coast, *D. spicata* is often associated with *Spartina patens*, saltmeadow hay, or with the short form of *Spartina alterniflora*, smooth cordgrass. *D. spicata* forms an extensive creeping rhizome system which produces dense sods and corresponding dense but low growth. These species provide nesting cover for waterfowl.

D. spicata

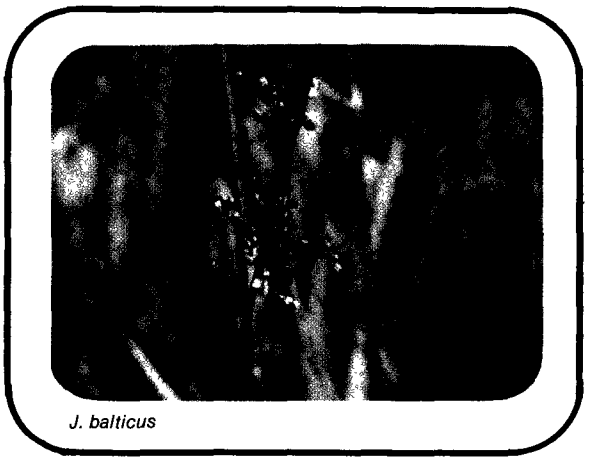

Distichlis spicata —
Delaware
Standing Crop Biomass
Net Primary Production:
2017 g/m²/yr
Dry Weight g/m²
1200
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Reimold and Linthurst, 1977)


Distichlis spicata —
Georgia
Standing Crop Biomass
Net Primary Production:
4378 g/m²/yr
Dry Weight g/m²
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Reimold and Linthurst, 1977)

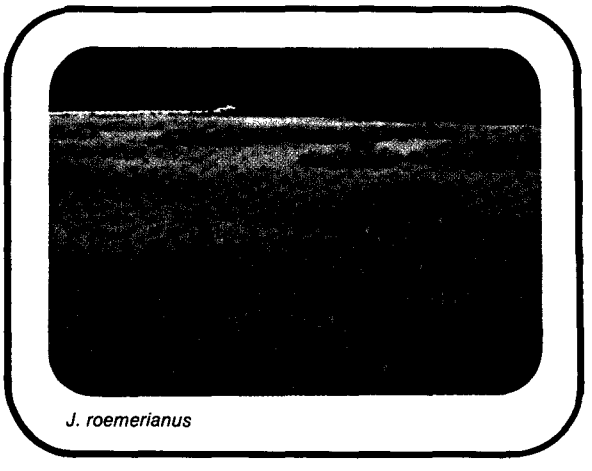

Distichlis spicata —
Oregon
Standing Crop Biomass
Net Primary Production:
1300 g/m²/yr
Dry Weight g/m²
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

JUNCUS
RUSH

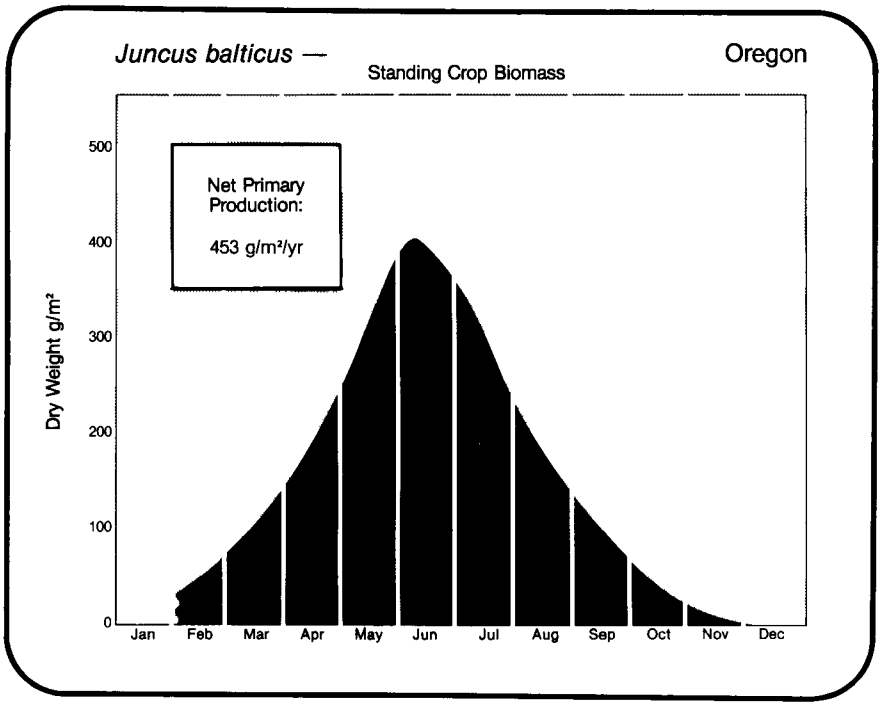
Juncus balticus is both an inland species which grows in fresh and alkali marshes, and a coastal species which inhabits the high intertidal region. In the Pacific Northwest, it often grows in the transition zone between marsh and upland. It is often found in association with *Deschampsia* (tuffed hairgrass), *Potentilla* (pacific silverweed) and *Agrostis*. *J. balticus* forms an extensive creeping rhizome system that holds soil in place. Its decomposition is extremely slow. *Juncus roemerianus*, black needle rush, is most common along the south Atlantic Coast and the Gulf of Mexico. It grows in high marsh areas and often forms large monospecific stands. The rhizomes form dense mats which prevent erosion. *Juncus gerardi*, mud rush, is common along both the Atlantic and Pacific Coasts. It is quite possibly an introduced species from Europe.

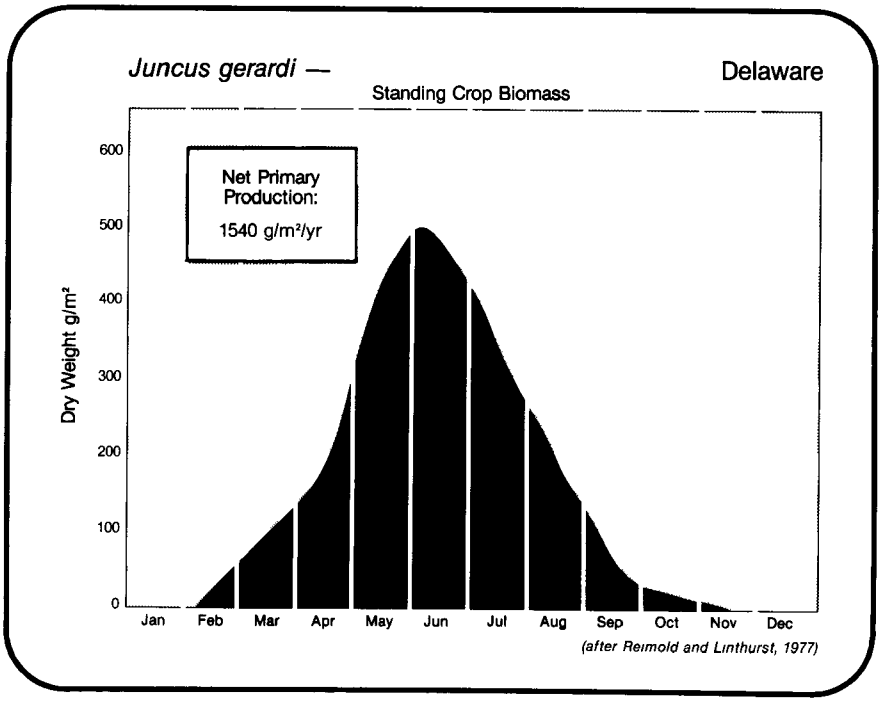


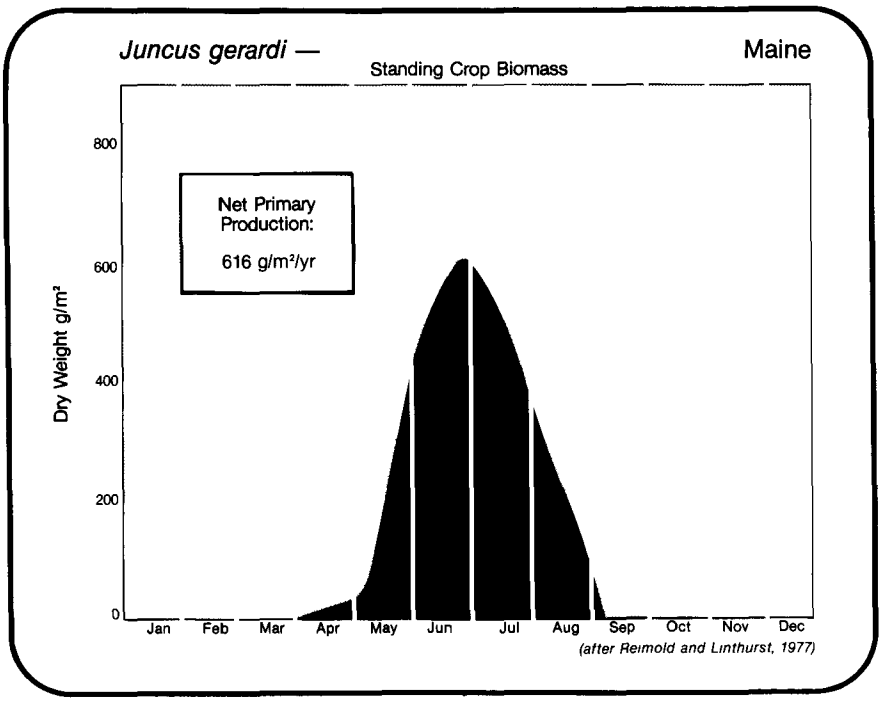
J. balticus

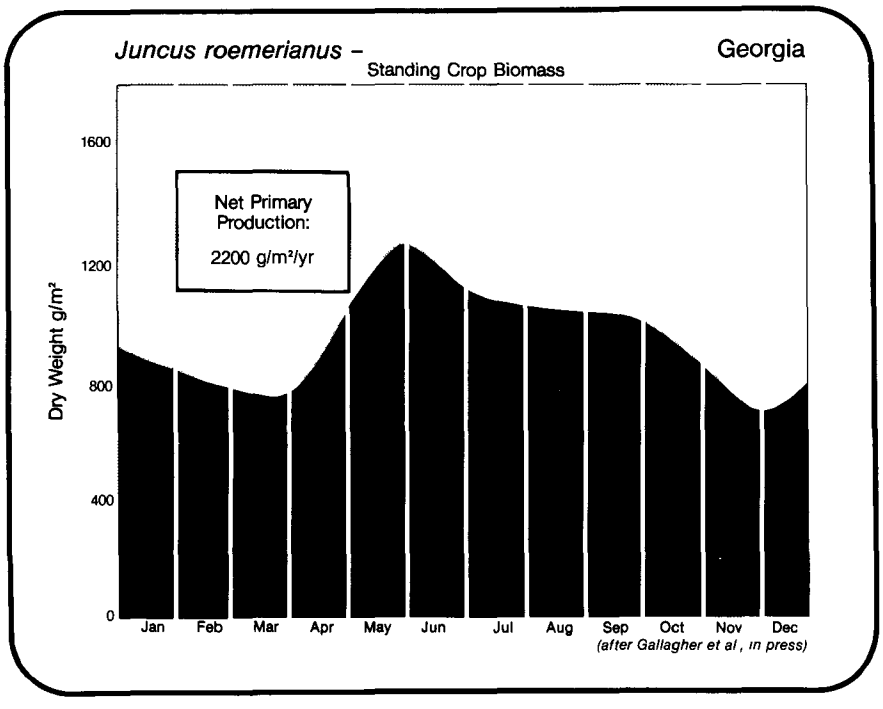


J. roemerianus


Juncus balticus —
Oregon
Standing Crop Biomass
Net Primary Production:
453 g/m²/yr
Dry Weight g/m²
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Juncus gerardi —
Delaware
Standing Crop Biomass
Net Primary Production:
1540 g/m²/yr
Dry Weight g/m²
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Reimold and Linthurst, 1977)

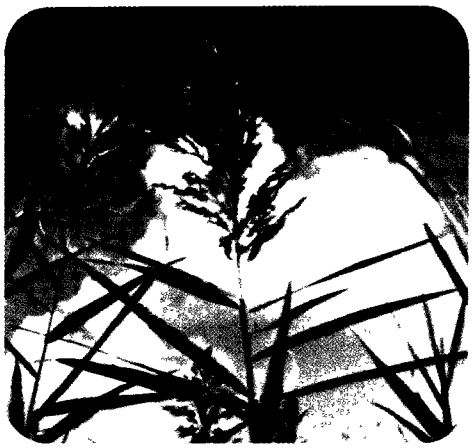

Juncus gerardi —
Maine
Standing Crop Biomass
Net Primary Production:
616 g/m²/yr
Dry Weight g/m²
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Reimold and Linthurst, 1977)


Juncus roemerianus –
Georgia
Standing Crop Biomass
Net Primary Production:
2200 g/m²/yr
Dry Weight g/m²
1600
1200
800
400
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Gallagher et al., in press)

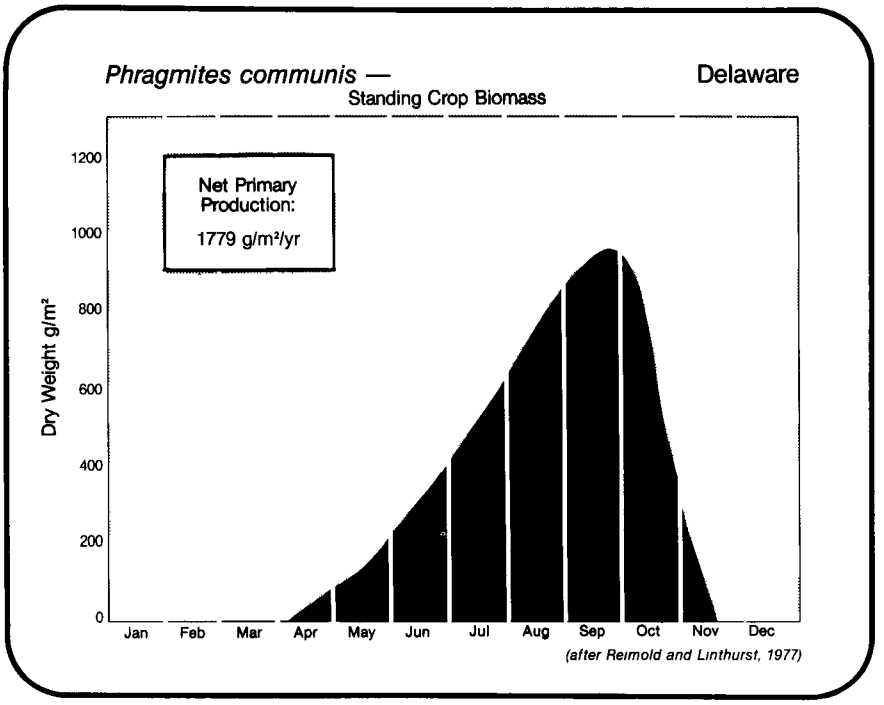
PHRAGMITES
REED GRASS

Phragmites communis or reed grass is a common plant of fresh and brackish waters along marshes throughout the world, and it is used for making paper in Eastern Europe. The creeping rhizomes allow it to quickly invade disturbed areas. It is considered by some to be a weed as it will generally out compete more valuable wildlife species. Reed grass is useful in controlling erosion from dredge spoil areas.

P. communis



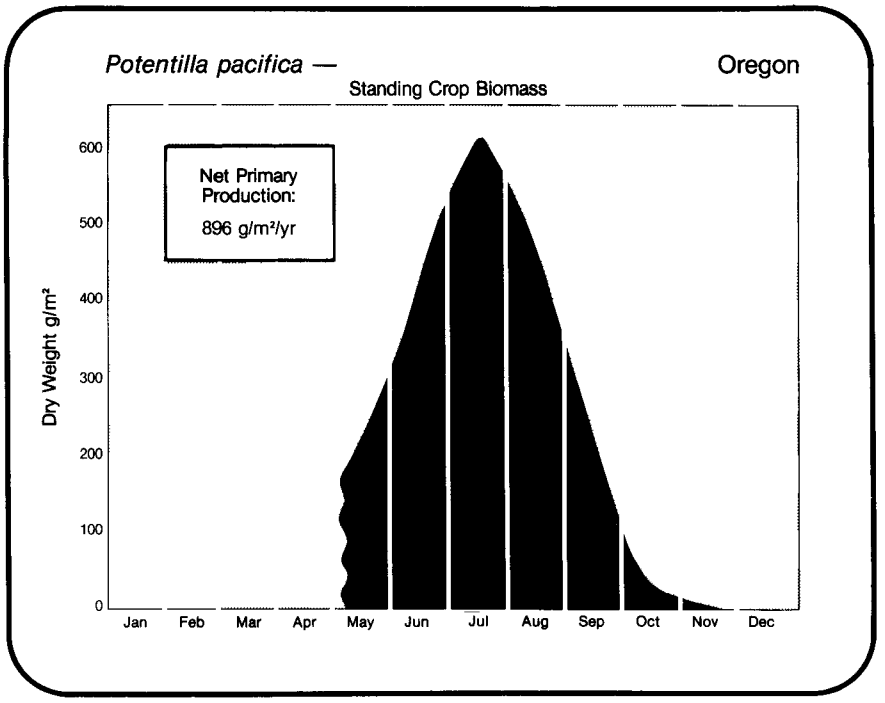
P. communis


Phragmites communis —
Delaware
Standing Crop Biomass
Net Primary Production:
1779 g/m²/yr
Dry Weight g/m²
1200
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Reimold and Linthurst, 1977)

POTENTILLA
PACIFIC SILVERWEED

Potentilla pacifica is widely distributed and grows in both fresh and saltwater communities. In many cases, this species is a good indicator of the transition zone. In the Pacific Northwest, this plant seldom grows in monospecific stands, but generally is found in a mixed community consisting of other species such as *Deschampsia* (tuffed hairgrass), *Juncus, Grindelia* (gumweed) or *Trifolium.*

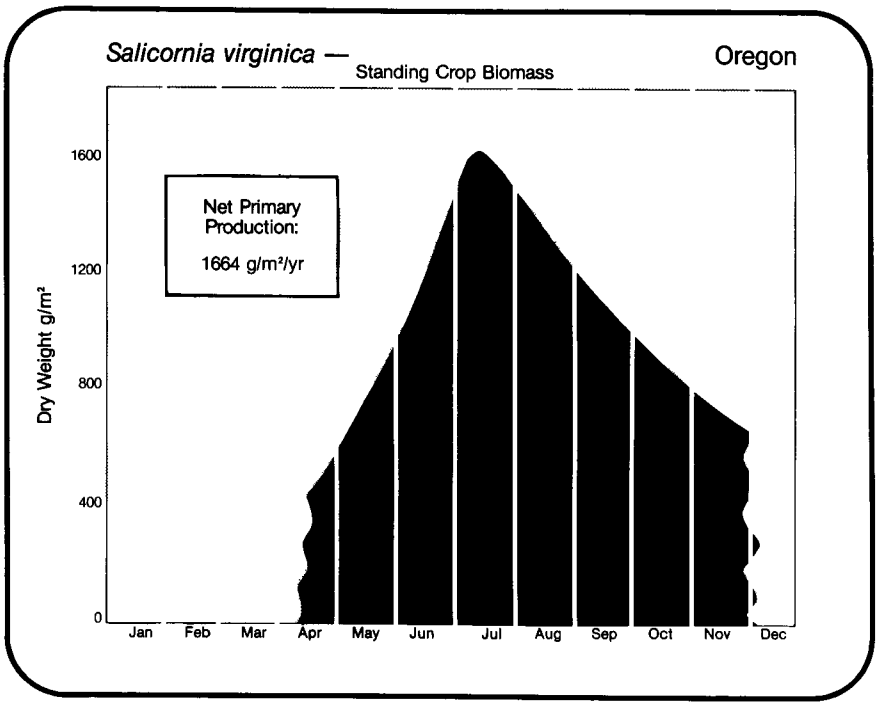
P. pacifica


Potentilla pacifica —
Oregon
Standing Crop Biomass
Net Primary Production:
896 g/m²/yr
Dry Weight g/m²
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

SALICORNIA
GLASSWORT

Species of *Salicornia* occur on all coasts and the interior parts of the west. *Salicornia virginica* (woody glasswort) is an intertidal species found in both brackish and saltwater marshes. This species is a succulent perennial with a wood-like stem. On the West Coast, it usually grows in dense mats and is often an early mudflat invader. On the East Coast, it generally grows at higher elevations in salt flats. Other common species in the United States include *S. europea* and *S. biglovii*. Geese feed on the fleshy parts. In the fall, ducks, particularly pintail, eat the seeds. The fleshy parts of all species of *Salicornia* may be used in salads or preserved.

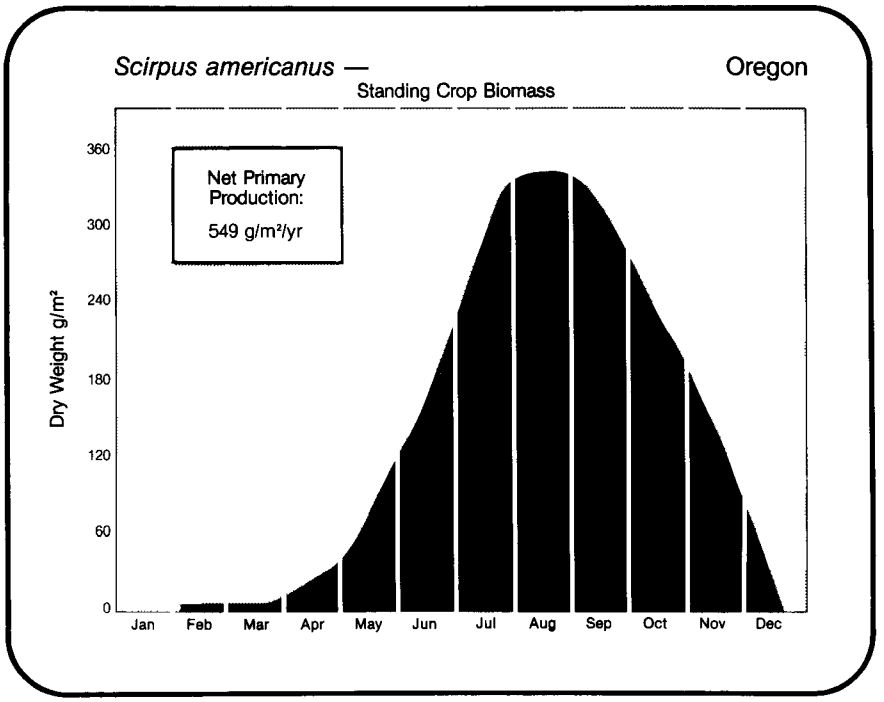
S. virginica

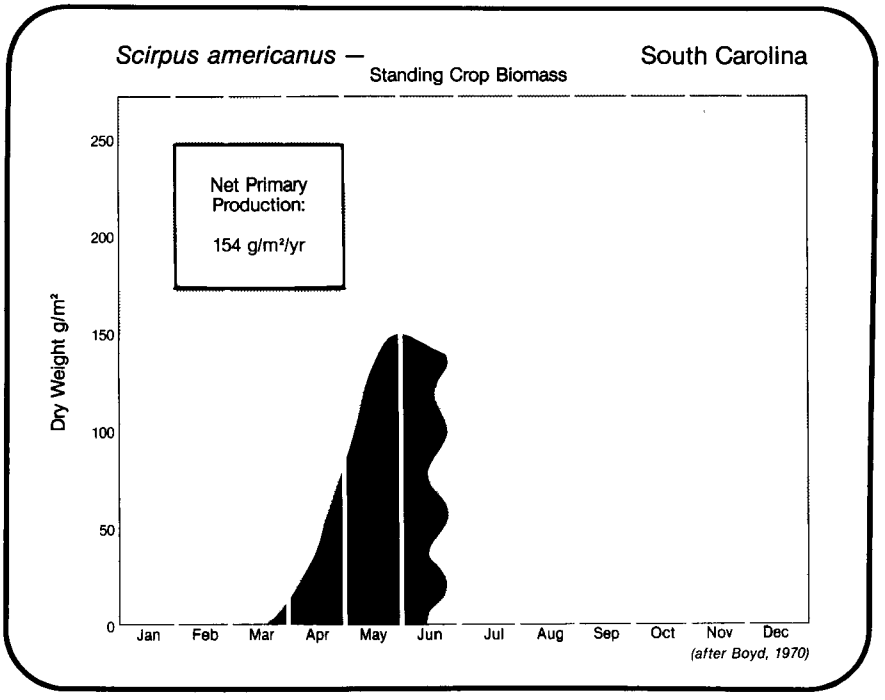

Salicornia virginica —
Standing Crop Biomass
Oregon
Net Primary Production:
1664 g/m²/yr
Dry Weight g/m²
1600
1200
800
400
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

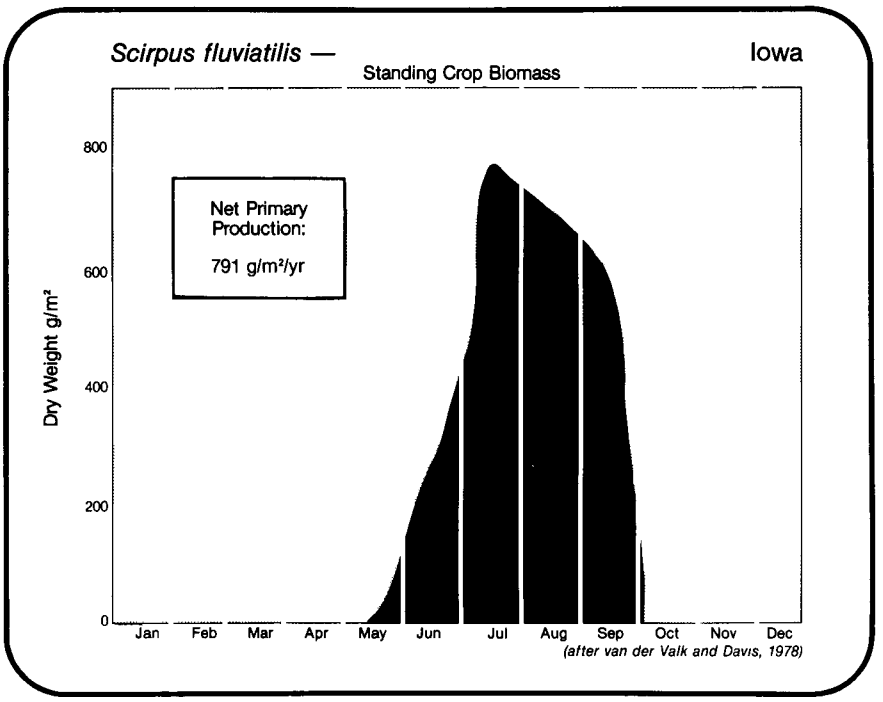
SCIRPUS
BULRUSH

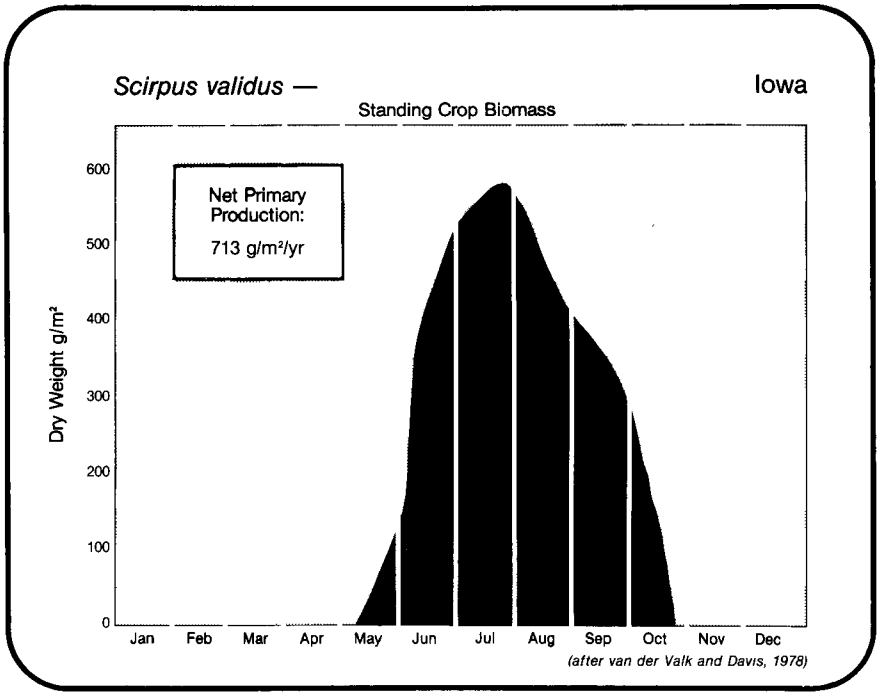
There are over forty North American species of the genus *Scirpus* throughout the United States. *Scirpus americanus*, threesquare, is an important species along fresh, brackish, and saline shores and in marshes. Generally, it does not form extensive stands, but forms shoreline fringes. In tidal areas, *S. americanus* is a low intertidal species that is often one of the first invaders on the mudflat; consequently, it acts as a sediment trap for building marsh areas. Since this species grows near water, its seeds are readily available to ducks. A close relative, *Scirpus olneyi*, Olney's threesquare, is a favorite food for muskrats. Other species that frequently occur in wetlands include *Scirpus robustus*, (saltmarsh bulrush), *Scirpus validus,* (giant bulrush), and *Scirpus fluviatilis*, (river bulrush).

Scirpus


Scirpus americanus —
Standing Crop Biomass
Oregon
Net Primary Production:
549 g/m²/yr
Dry Weight g/m²
360
300
240
180
120
60
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

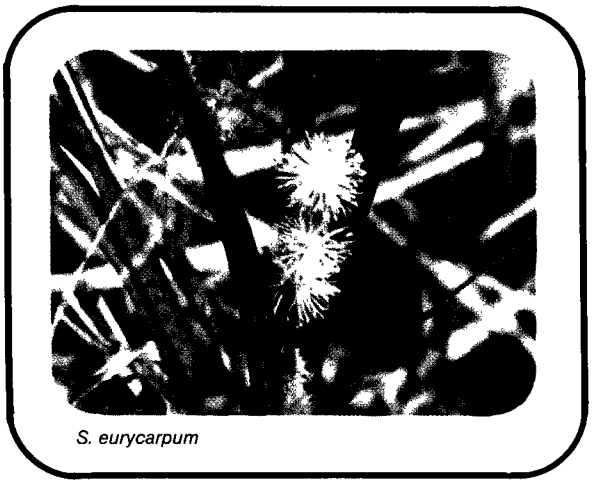

Scirpus americanus —
Standing Crop Biomass
South Carolina
Net Primary Production:
154 g/m²/yr
Dry Weight g/m²
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Boyd, 1970)


Scirpus fluviatilis —
Iowa
Standing Crop Biomass
Net Primary Production:
791 g/m²/yr
Dry Weight g/m²
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after van der Valk and Davis, 1978)

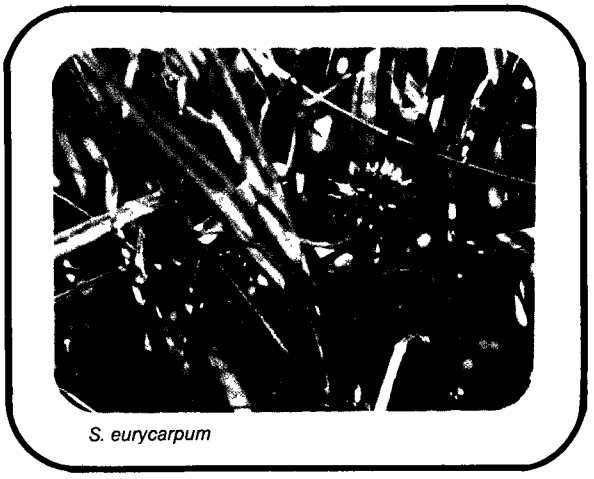

Scirpus validus —
Iowa
Standing Crop Biomass
Net Primary Production:
713 g/m²/yr
Dry Weight g/m²
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after van der Valk and Davis, 1978)

SPARGANIUM
BUR REED

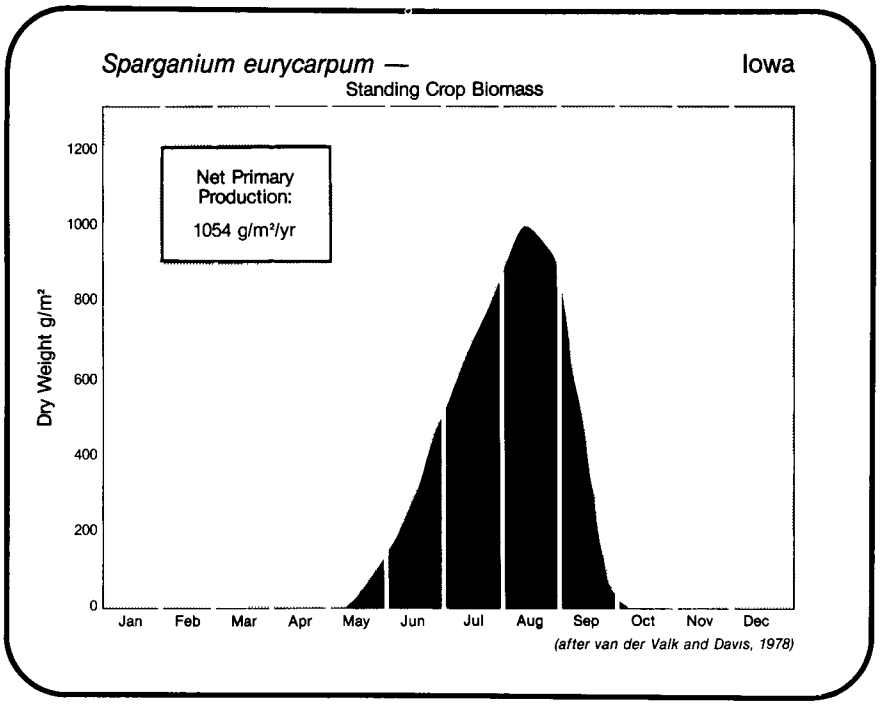
Sparganium, or bur reeds, grow throughout the United States in inland freshwater marshes and aquatic areas. Plants range from ankle high to head high and are distinguished by a ball-shaped seed head.



S. eurycarpum

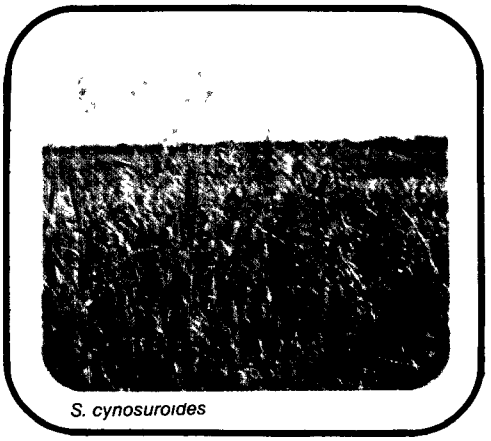


S. eurycarpum

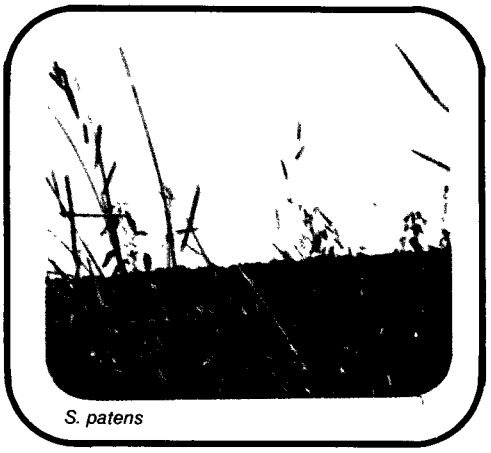

Sparganium eurycarpum —
Iowa
Standing Crop Biomass
Net Primary Production:
1054 g/m²/yr
Dry Weight g/m²
1200
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after van der Valk and Davis, 1978)

SPARTINA
CORDGRASS

S. alterniflora

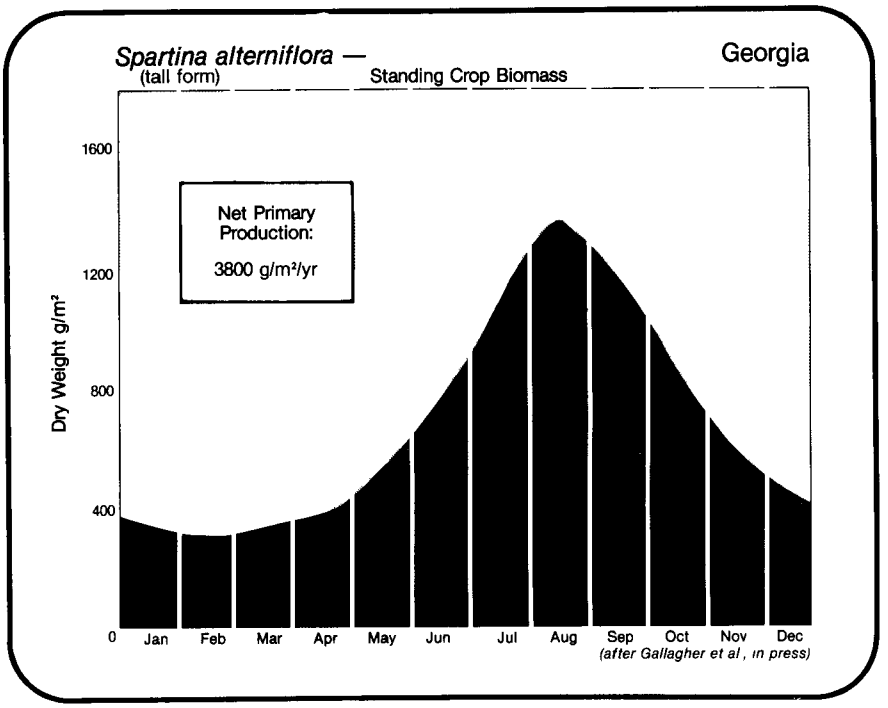


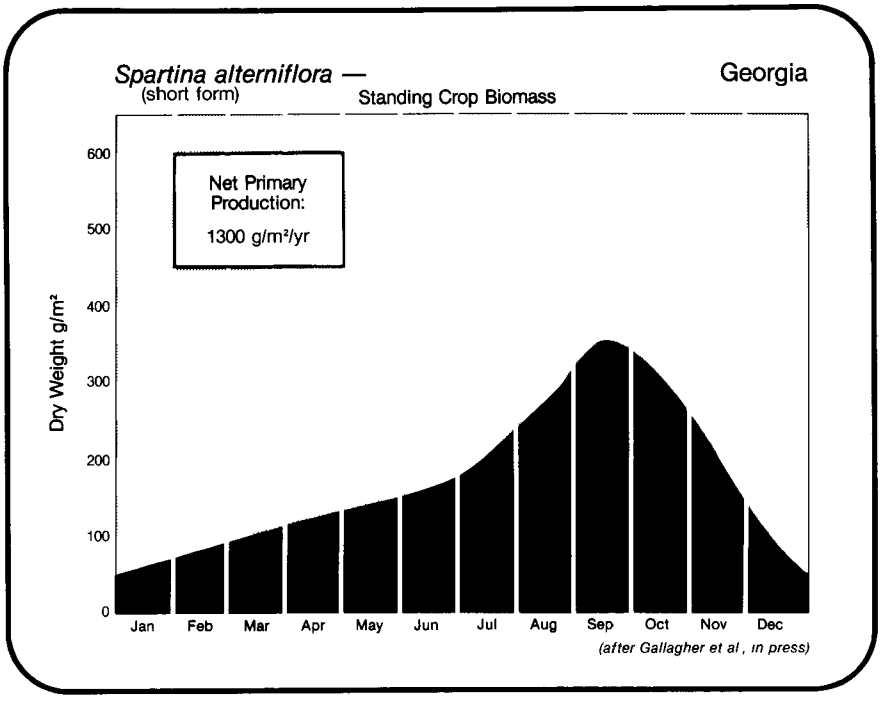
S. cynosuroides

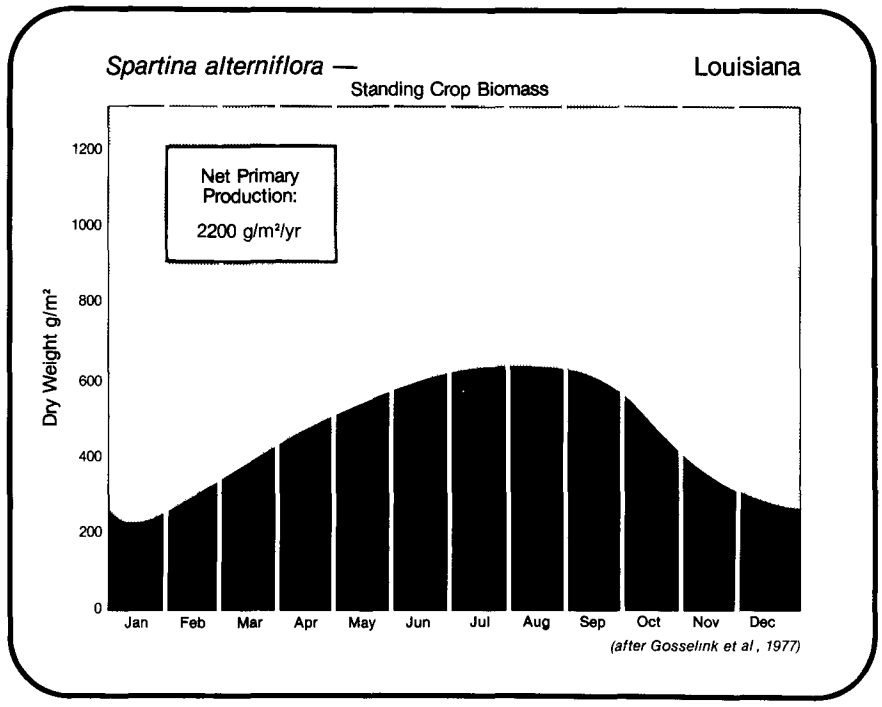


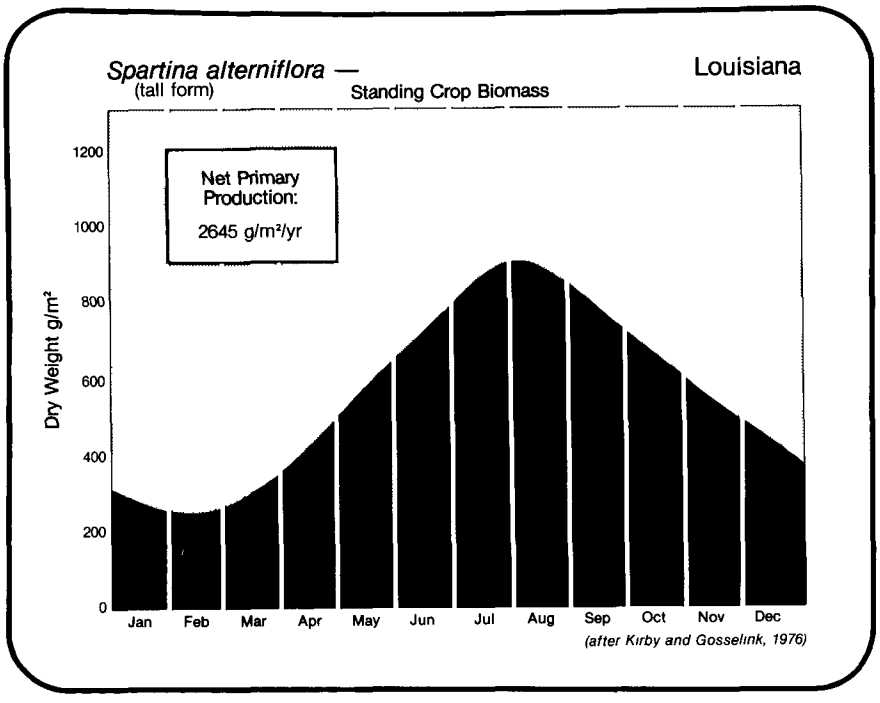
S. patens

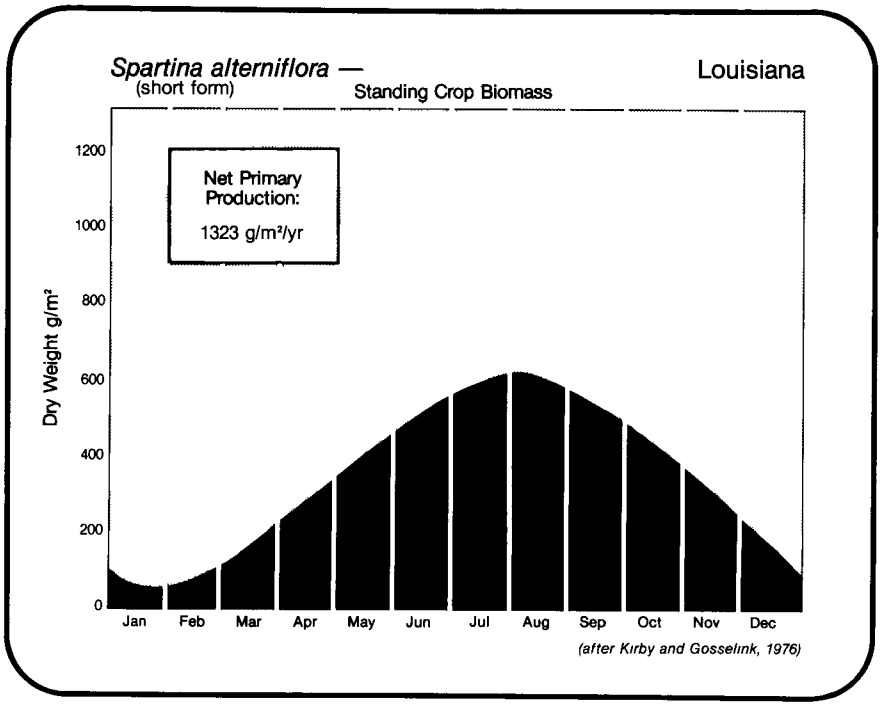
There are three important *Spartina* species common to the coastal marshes of the United States. *S. alterniflora* (smooth cordgrass) is the dominant species of Atlantic and gulf coast salt marshes. This intertidal species has two growth forms, a tall form growing adjacent to waterways and a short form in the marsh areas away from the banks, and is important to estuarine food webs. *S. cynosuroides* (big cordgrass) grows in low salinities along the Atlantic and gulf coasts. In addition to its food value for wildlife, muskrats often use this species in construction. *S. patens* (saltmeadow cordgrass) grows along all three coasts. It generally is found at slightly higher elevation than *S. alterniflora.* Another common species is *S. foliosa* which occurs primarily on the West Coast. All forms of *Spartina* are important waterfowl food.

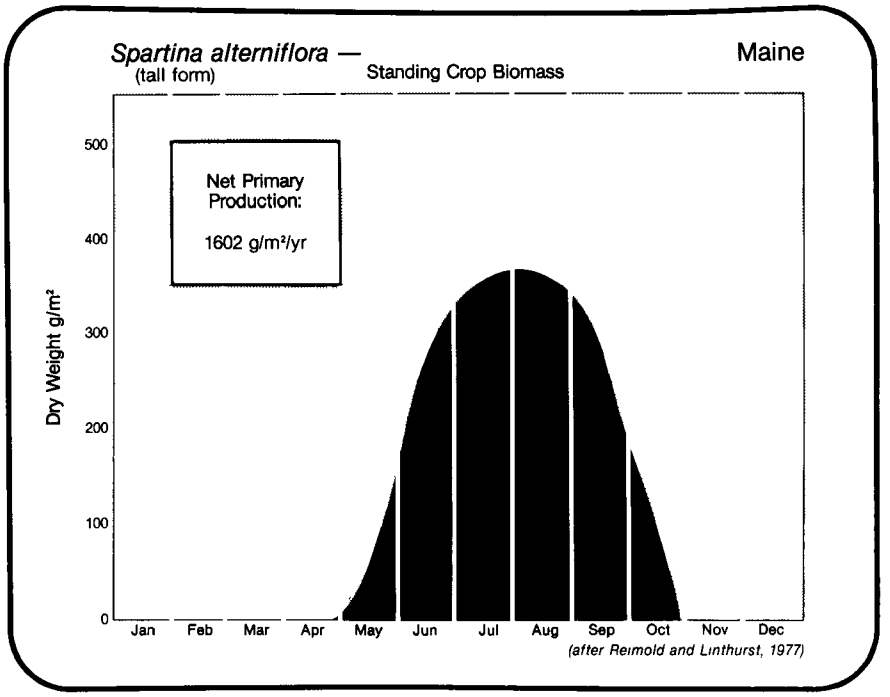

Spartina alterniflora —
(tall form)
Standing Crop Biomass
Georgia
Net Primary Production:
3800 g/m²/yr
Dry Weight g/m²
1600
1200
800
400
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Gallagher et al., in press)

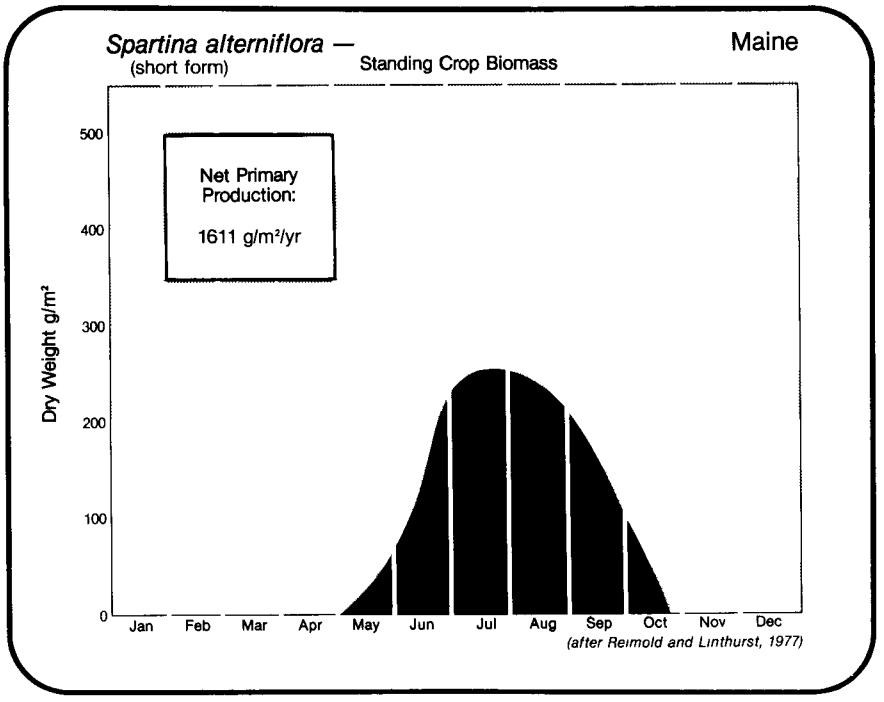

Spartina alterniflora —
(short form)
Standing Crop Biomass
Georgia
Net Primary Production:
1300 g/m²/yr
Dry Weight g/m²
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Gallagher et al., in press)

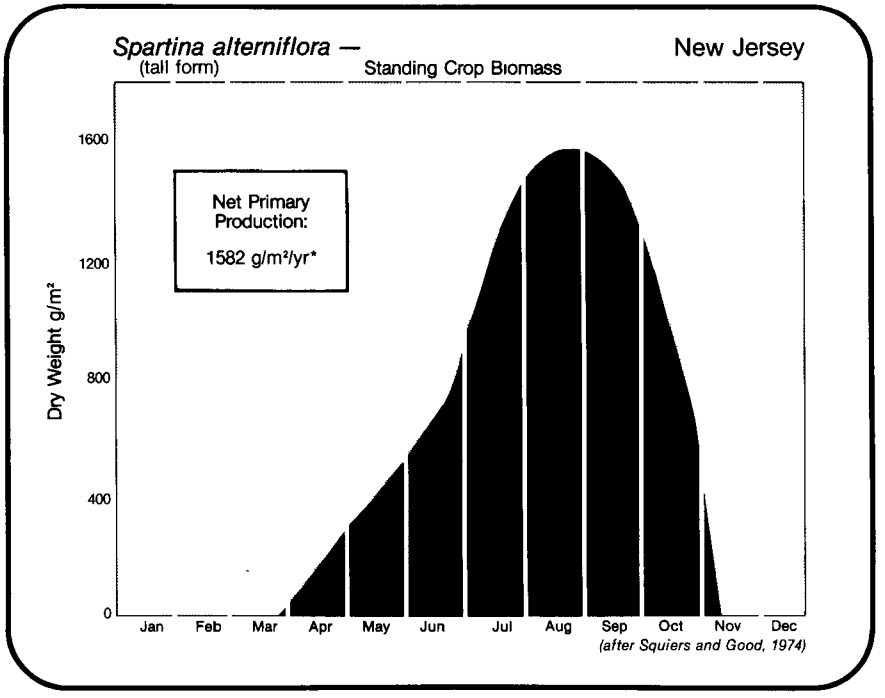

Spartina alterniflora —
Louisiana
Standing Crop Biomass
Net Primary Production:
2200 g/m²/yr
Dry Weight g/m²
1200
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Gosselink et al, 1977)

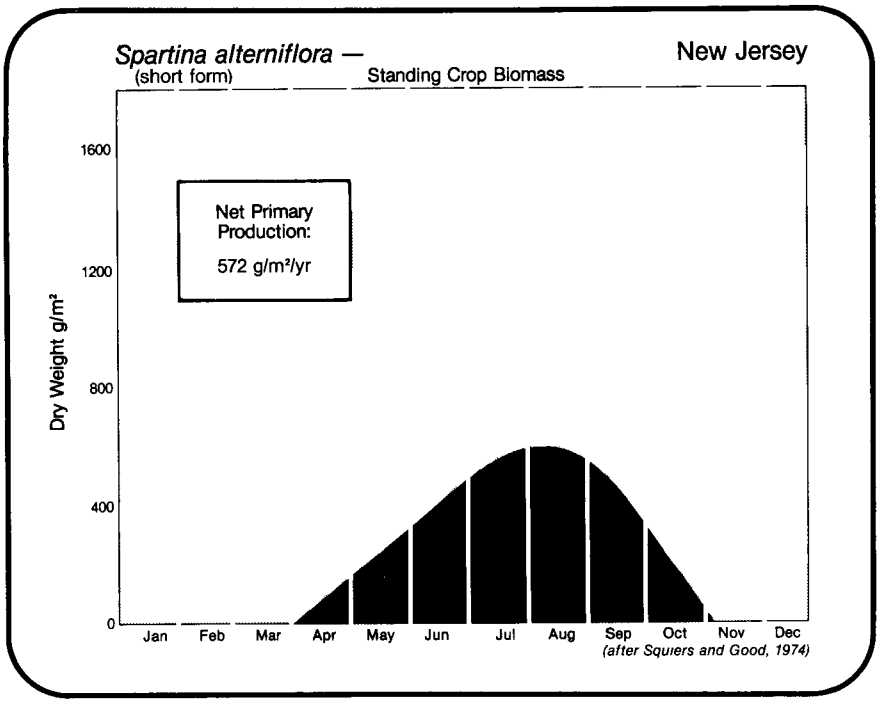

Spartina alterniflora —
(tall form)
Louisiana
Standing Crop Biomass
Net Primary Production:
2645 g/m²/yr
Dry Weight g/m²
1200
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Kirby and Gosselink, 1976)

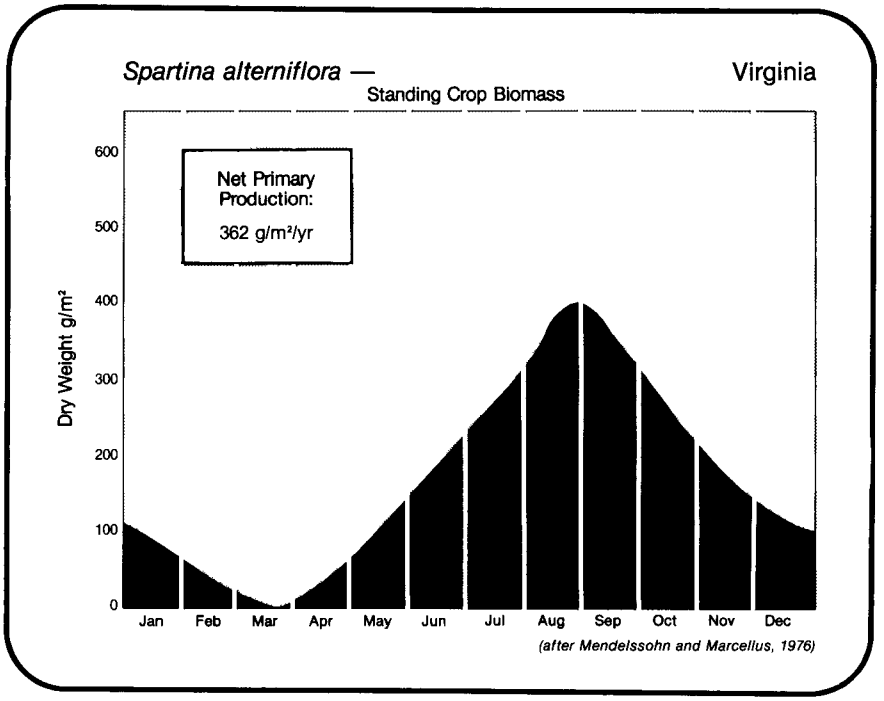

Spartina alterniflora —
(short form)
Standing Crop Biomass
Louisiana
Net Primary Production:
1323 g/m²/yr
Dry Weight g/m²
1200
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Kirby and Gosselink, 1976)

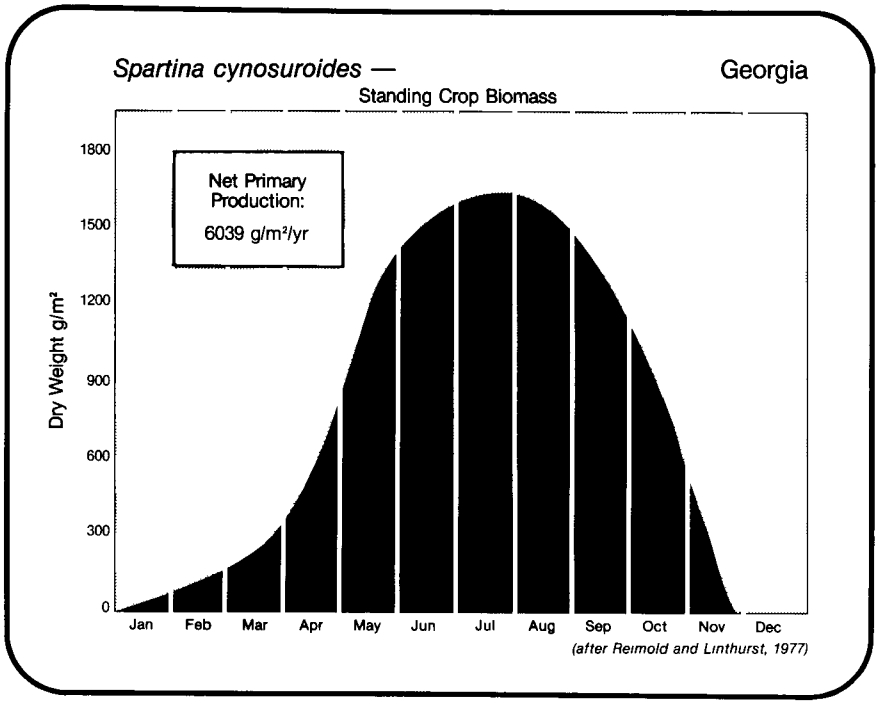

Spartina alterniflora —
(tall form)
Standing Crop Biomass
Maine
Net Primary Production:
1602 g/m²/yr
Dry Weight g/m²
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Reimold and Linthurst, 1977)

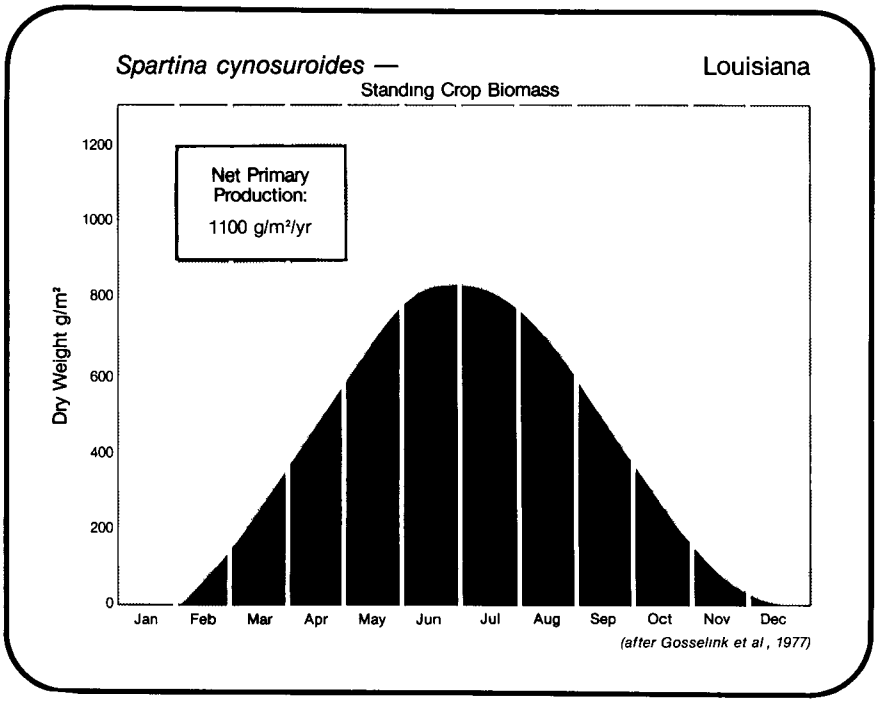

Spartina alterniflora —
(short form)
Standing Crop Biomass
Maine
Net Primary Production:
1611 g/m²/yr
Dry Weight g/m²
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Reimold and Linthurst, 1977)

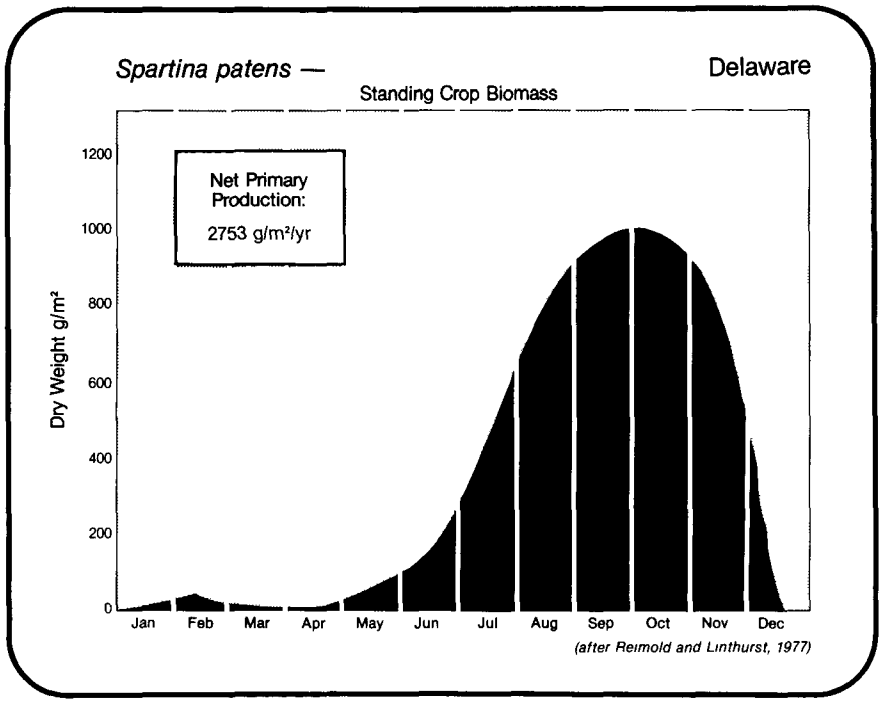

Spartina alterniflora —
(tall form)
Standing Crop Biomass
New Jersey
Net Primary Production:
1582 g/m²/yr*
Dry Weight g/m²
1600
1200
800
400
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Squiers and Good, 1974)

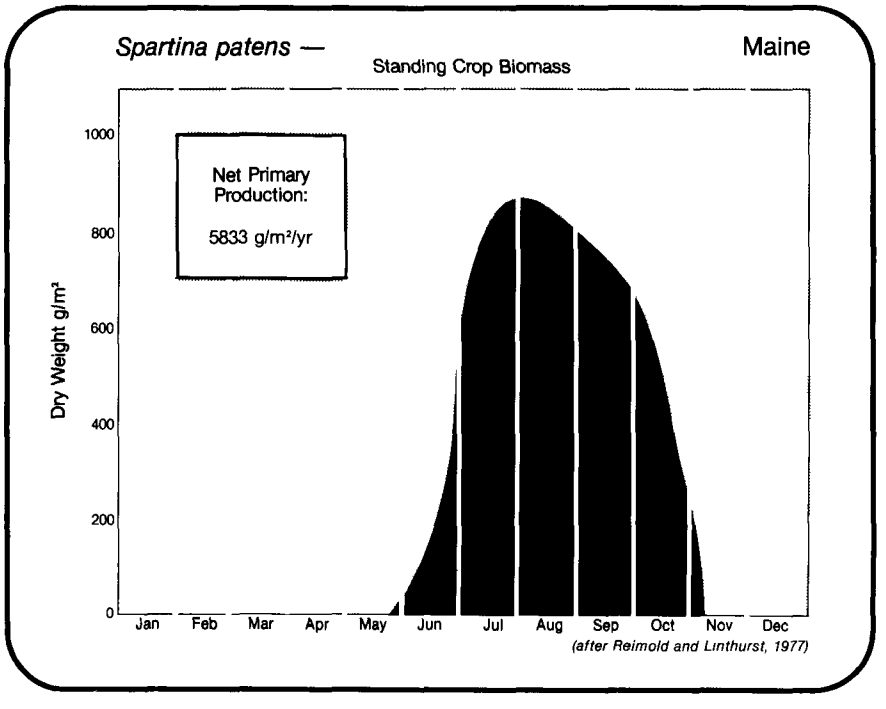

Spartina alterniflora —
(short form)
New Jersey
Standing Crop Biomass
Net Primary Production:
572 g/m²/yr
Dry Weight g/m²
1600
1200
800
400
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Squiers and Good, 1974)


Spartina alterniflora —
Virginia
Standing Crop Biomass
Net Primary Production:
362 g/m²/yr
Dry Weight g/m²
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Mendelssohn and Marcellus, 1976)


Spartina cynosuroides —
Georgia
Standing Crop Biomass
Net Primary Production:
6039 g/m²/yr
Dry Weight g/m²
1800
1500
1200
900
600
300
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Reimold and Linthurst, 1977)


Spartina cynosuroides —
Louisiana
Standing Crop Biomass
Net Primary Production:
1100 g/m²/yr
Dry Weight g/m²
1200
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Gosselink et al, 1977)

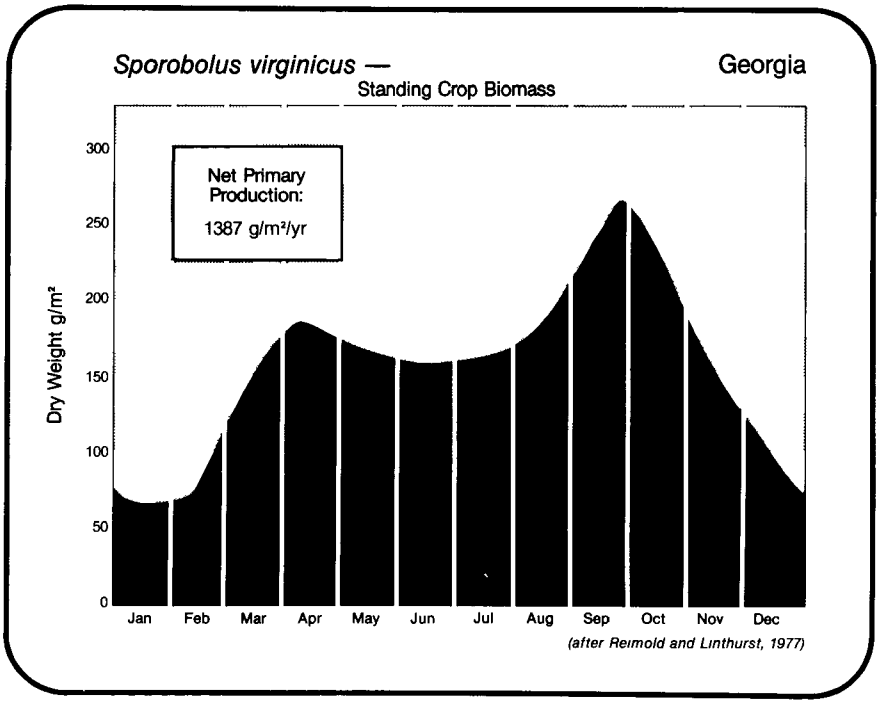

Spartina patens —
Delaware
Standing Crop Biomass
Net Primary Production:
2753 g/m²/yr
Dry Weight g/m²
1200
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Reimold and Linthurst, 1977)


Spartina patens —
Maine
Standing Crop Biomass
Net Primary Production:
5833 g/m²/yr
Dry Weight g/m²
1000
800
600
400
200
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Reimold and Linthurst, 1977)

SPOROBOLUS
DROPSEED

Sporobolus, or dropseed, is a low-growing fleshy plant that grows in southern regions of the United States. *S. virginicus* occurs along the east and gulf coasts from North Carolina to Texas. Other species occur in Southern California and inland areas. Some species grow in upland areas of blowing sand and sand dunes.

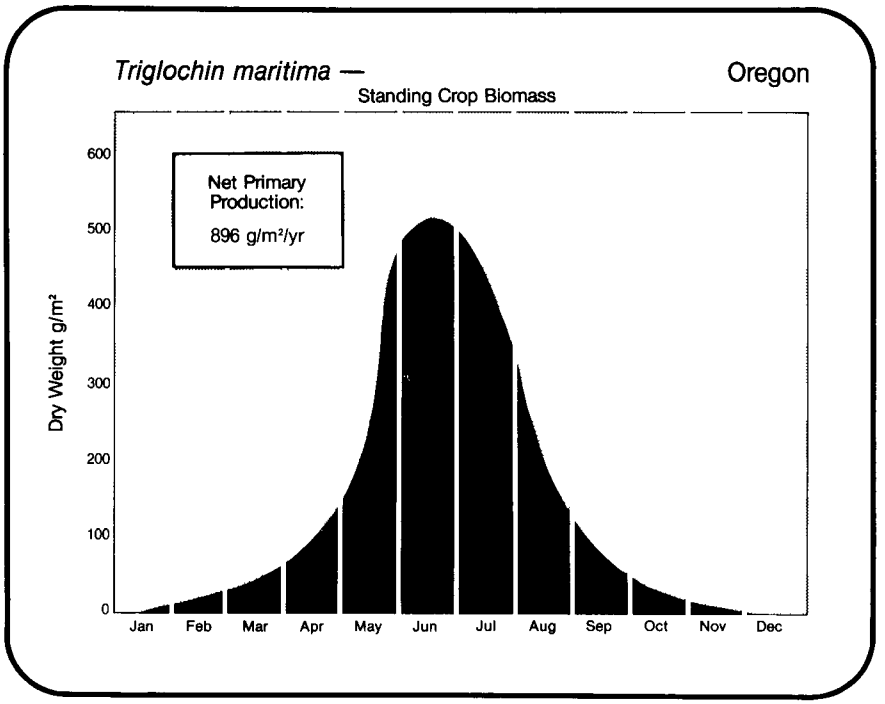
S. virginicus


Sporobolus virginicus —
Georgia
Standing Crop Biomass
Net Primary Production:
1387 g/m²/yr
Dry Weight g/m²
300
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Reimold and Linthurst, 1977)

TRIGLOCHIN
SEASIDE ARROWGRASS

Triglochin maritima is found in fresh, brackish, and saline marshes from California to Alaska, and from Newfoundland to Delaware. It has also been reported in Nebraska and New Mexico. In coastal areas, *Triglochin* is often a primary invader on intertidal mudflats and, as a colonizer, increases the sedimentation rate. Consequently, this species is important in natural marsh building processes.

T. maritima

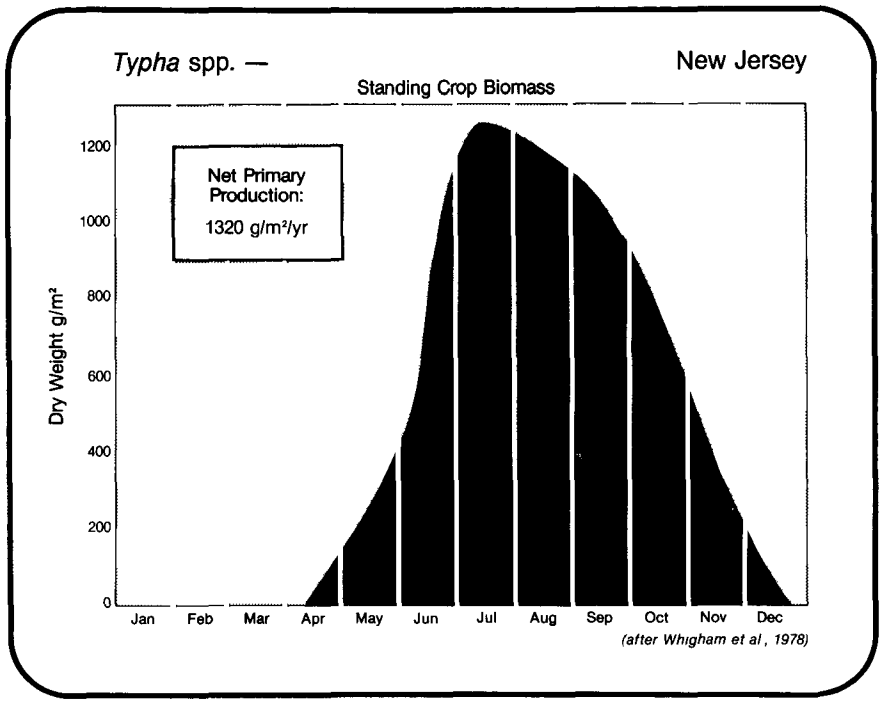

Triglochin maritima —
Oregon
Standing Crop Biomass
Net Primary Production:
896 g/m²/yr
Dry Weight g/m²
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

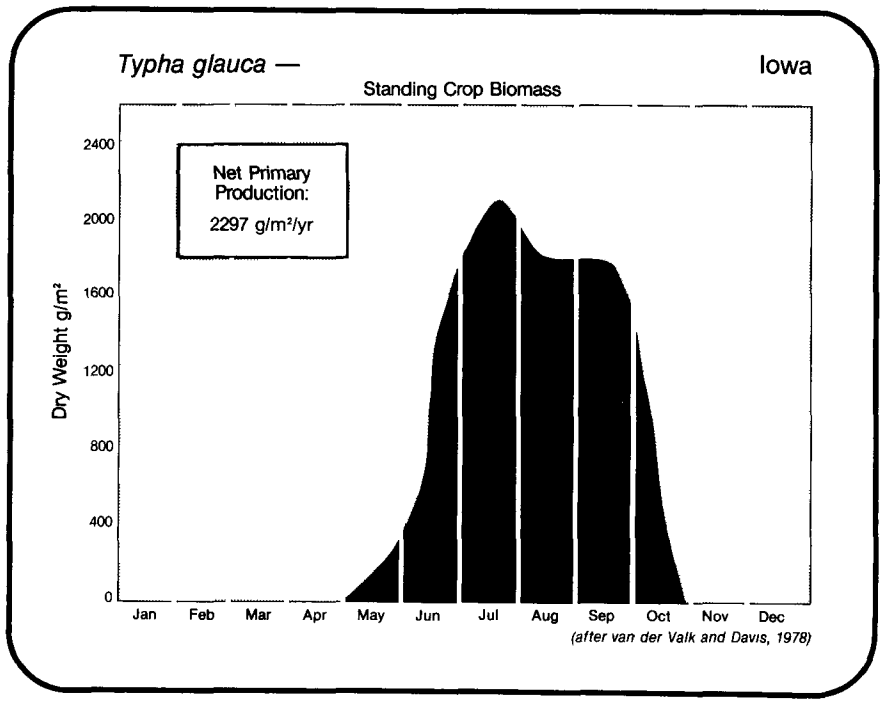
TYPHA
CATTAILS

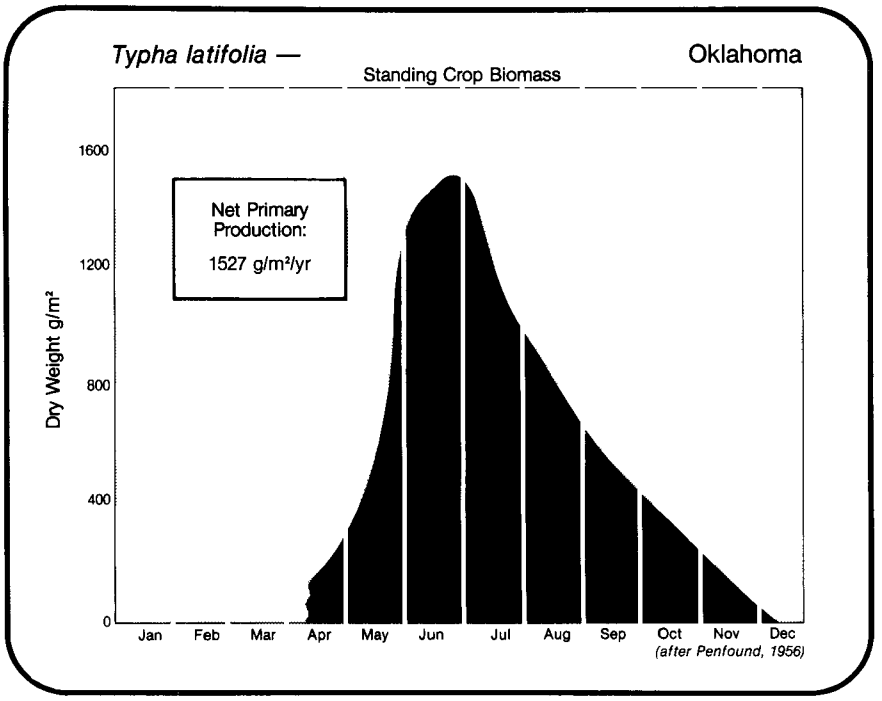
Four species of *Typha*, or cattails, are found in both inland and coastal wetlands of the United States. The most common species are *T. latifolia* (broadleaf cattail), a freshwater species well distributed throughout all states, and *T. angustifolia* (narrow leaved cattail), a fresh or brackish water species most common in the Northeast. Less commonly, *T. angustifolia* occurs in northern states from Washington to Nova Scotia and in southern states, and when it does occur in brackish areas, it is where there is freshwater seepage. Two other common species are *T. domigensis* (southern cattail) and *T. glauca* (blue cattail).

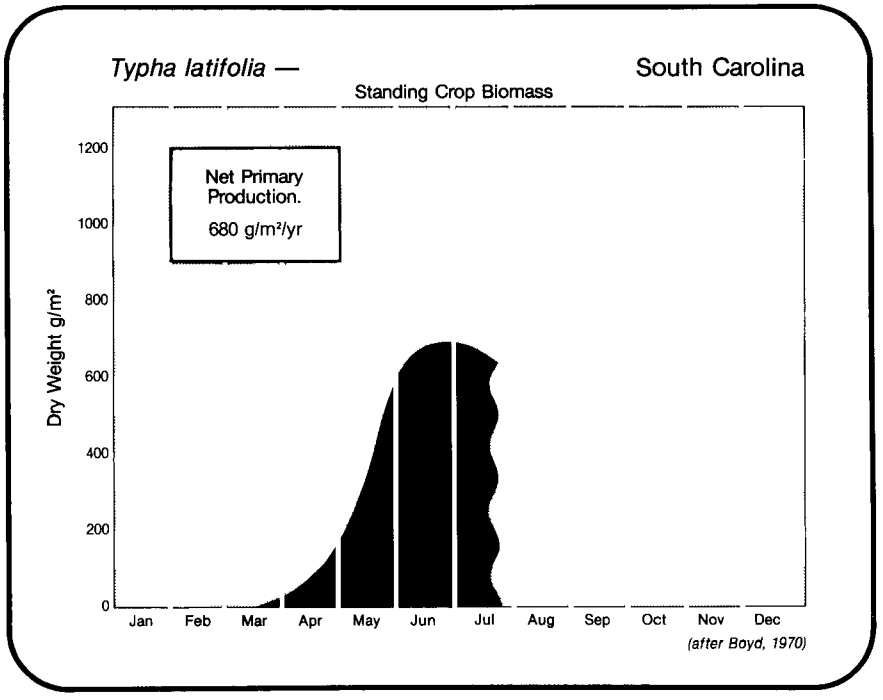
All *Typha* species tend to grow in dense colonies. The aerial parts provide a nesting habitat for many organisms while the roots provide feed for muskrats and geese. Cattail marshes are excellent habitats for muskrats but are of little value in marshes managed for ducks.

T. angustifolia


Typha spp. —
New Jersey
Standing Crop Biomass
Net Primary Production:
1320 g/m²/yr
Dry Weight g/m²
0
200
400
600
800
1000
1200
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after Whigham et al, 1978)


Typha glauca —
Iowa
Standing Crop Biomass
Net Primary Production:
2297 g/m²/yr
Dry Weight g/m²
0
400
800
1200
1600
2000
2400
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
(after van der Valk and Davis, 1978)


Typha latifolia —
Oklahoma
Standing Crop Biomass
Net Primary Production:
1527 g/m²/yr
Dry Weight g/m²
1600
1200
800
400
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
(after Penfound, 1956)


Typha latifolia —
South Carolina
Standing Crop Biomass
Net Primary Production.
680 g/m²/yr
Dry Weight g/m²
1200
1000
800
600
400
200
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
(after Boyd, 1970)

Literature Cited

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Appendix A. Conversion Factors from Fresh to Dry Weight of Living and Dead Marsh Plants

Species	Dry weight as average % of wet weight	
	Live Plants	Dead Plants
Carex lyngbyei	25	40
Distichlis spicata	45	60
Juncus balticus	50	65
Juncus roemerianus	40	50
Phragmites communis	50	80
Potentilla pacifica	20	30
Salicornia virginica	30	45
Scirpus americanus	20	20
Sparganium eurycarpum	30	30
Spartina alterniflora	35	35
Spartina cynosuroides	50	85
Spartina foliosa	30	70
Spartina patens	70	65
Sporobolus virginicus	60	60
Triglochin maritima	15	20
Typha	50	30

Appendix B. Unit Conversion Table

To Convert Column 1 to Column 2 multiply by	Column 1	Column 2	To Convert Column 2 to Column 1 multiply by
2.471	hectares (ha)	acres	0.405
3.281	meters (m)	feet (f)	0.305
10.764	sq meters (m^2)	sq feet (ft^2)	0.093
0.035	grams (g)	ounce (oz)	28.35
2.205	kilograms (kg)	pounds (lbs)	0.454
0.892	kg/ha	lb/acre	1.12
4048.	sq meters	acre	.00025
0.0044	gm/m^2	tons/acre	226.0
0.621	kilometers	miles	1.609
0.1	millimeters	centimeters	10
0.01	centimeters	meters	100
0.001	meters	kilometers	1000
0.001	grams	kilograms	1000