

## Common patterns, common drivers: comparative analysis of aggregate surplus production across ecosystems

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**Supplement.** Principal marine species, years of data and data sources for the aggregate biomass, landings and environmental and biological covariates for each system

Table S1. The years of data, principal marine species, and data sources for the aggregate biomass and landings for each system. Biomass data types include stock assessment (SA); swept-area estimates of survey biomass—not corrected for catchability (MAF), and corrected for catchability (SBE); and acoustic survey biomass (AS). ns = not specified,  $q$  = catchability co-efficient (to trawl survey gear)

Common Name	Taxon	Biomass Data Type	Biomass Data Source	Landings Data Source
<b>GULF OF ALASKA, 1984 – 2009</b>				
Arrowtooth flounder	<i>Atheresthes stomias</i>	SA	1	1
Dover sole	<i>Microstomus pacificus</i>	SA	1	1
Dusky rockfish	<i>Sebastes ciliatus</i>	SA	1	1
Flathead sole	<i>Hippoglossoides elassodon</i>	SA	1	1
Northern rockfish	<i>Sebastes polyspinis</i>	SA	1	1
Pacific cod	<i>Gadus macrocephalus</i>	SA	1	1
Pacific halibut	<i>Hippoglossus stenolepis</i>	SA	2	2
Pacific herring	<i>Clupea pallasii</i>	SA	3	3
Pacific ocean perch	<i>Sebastes alutus</i>	SA	1	1
Rex sole	<i>Glyptocephalus zachirus</i>	SA	1	1
Rougheye rockfish	<i>Sebastes aleutianus</i>	SA	1	1
Sablefish	<i>Anoplopoma fimbria</i>	SA	1	1
Walleye pollock	<i>Theragra chalcogramma</i>	SA	1	1
<b>EASTERN BERING SEA, 1977 – 2009</b>				
Alaska plaice	<i>Pleuronectes quadrituberculatus</i>	SA	4	4
Arrowtooth flounder	<i>Atheresthes stomias</i>	SA	4	4
Flathead sole	<i>Hippoglossoides elassodon</i>	SA	4	4
Greenland halibut	<i>Reinhardtius hippoglossoides</i>	SA	4	4

Northern rock sole	<i>Lepidopsetta polyxystra</i>	SA	4	4
Pacific cod	<i>Gadus macrocephalus</i>	SA	4	4
Walleye pollock	<i>Theragra chalcogramma</i>	SA	4	4
Yellowfin sole	<i>Limanda aspera</i>	SA	4	4
<b>EASTERN SCOTIAN SHELF, 1970 – 2009</b>				
Alewife	<i>Alosa pseudoharengus</i>	SBE	5	5
American plaice	<i>Hippoglossoides platessoides</i>	SBE	5	5
Atlantic argentine	<i>Argentina silus</i>	SBE	5	5
Atlantic cod	<i>Gadus morhua</i>	SBE	5	5
Atlantic halibut	<i>Hippoglossus hippoglossus</i>	SBE	5	5
Atlantic redfishes (ns)	<i>Sebastes</i> spp.	SBE	5	5
Cusk	<i>Brosme brosme</i>	SBE	5	5
Finfishes (ns)	All commercial finfish, excluding flatfish	SBE	5	5
Flatfishes (ns)	<i>Hippoglossoides platessoides, Pseudopleuronectes americanus, Glyptocephalus cynoglossus, Limanda ferruginea</i>	SBE	5	5
Goosefish	<i>Lophius americanus</i>	SBE	5	5
Greenland halibut	<i>Reinhardtius hippoglossoides</i>	SBE	5	5
Groundfish other (ns)	Unspecified	SBE	5	5
Haddock	<i>Melanogrammus aeglefinus</i>	SBE	5	5
Lumpfish	<i>Cyclopterus lumpus</i>	SBE	5	5
Pollock	<i>Pollachius virens</i>	SBE	5	5
Red hake	<i>Urophycis chuss</i>	SBE	5	5
Silver hake	<i>Merluccius bilinearis</i>	SBE	5	5
Skates (ns)	Rajidae	SBE	5	5
Spiny dogfish	<i>Squalus acanthias</i>	SBE	5	5
White hake	<i>Urophycis tenuis</i>	SBE	5	5
Winter flounder	<i>Pseudopleuronectes americanus</i>	SBE	5	5
Witch flounder	<i>Glyptocephalus cynoglossus</i>	SBE	5	5
Wolffishes (ns)	<i>Anarhichas</i> spp.	SBE	5	5
Yellowtail flounder	<i>Limanda ferruginea</i>	SBE	5	5
<b>WESTERN SCOTIAN SHELF, 1970 – 2009</b>				
Alewife	<i>Alosa pseudoharengus</i>	SBE	5	5
American plaice	<i>Hippoglossoides platessoides</i>	SBE	5	5
Atlantic argentine	<i>Argentina silus</i>	SBE	5	5
Atlantic cod	<i>Gadus morhua</i>	SBE <sub>(1970-2009)</sub>	5	5
Atlantic halibut	<i>Hippoglossus hippoglossus</i>	SBE	5	5
Atlantic herring	<i>Clupea harengus</i>	SA, AS	6	5
Atlantic redfishes (ns)	<i>Sebastes</i> spp.	SBE	5	5
Cusk	<i>Brosme brosme</i>	SBE	5	5
Goosefish	<i>Lophius americanus</i>	SBE	5	5
Haddock	<i>Melanogrammus aeglefinus</i>	SBE <sub>(1970-2009)</sub>	5	5
Pollock	<i>Pollachius virens</i>	SBE <sub>(1970-2009)</sub>	5	5
Red hake	<i>Urophycis chuss</i>	SBE	5	5
Sculpin	Family Cottidae	SBE	5	5
Shad	<i>Alosa sapidissima</i>	SBE	5	5
Silver hake	<i>Merluccius bilinearis</i>	SBE	5	5
Skate (ns)	Family Rajidae	SBE	5	5
Spiny dogfish	<i>Squalus acanthias</i>	SBE	5	5

White hake	<i>Urophycis tenuis</i>	SBE	5	5
Winter flounder	<i>Pseudopleuronectes americanus</i>	SBE	5	5
Witch flounder	<i>Glyptocephalus cynoglossus</i>	SBE	5	5
Wolffishes (ns)	<i>Anarhichas</i> spp.	SBE	5	5
Yellowtail flounder	<i>Limanda ferruginea</i>	SBE	5	5
groundfish, unspecified	Unspecified	SBE	5	5
<b>NORWEGIAN SEA, 1981 – 2009</b>				
Atlantic herring <sup>a</sup>	<i>Clupea harengus</i>	SA	7, 8	7, 8
Atlantic mackerel <sup>b</sup>	<i>Scomber scombrus</i>	SA	8	8
Blue whiting <sup>c</sup>	<i>Micromesistius poutassou</i>	SA	8	9
<b>BARENTS SEA, 1986 – 2009</b>				
Atlantic cod <sup>d</sup>	<i>Gadus morhua</i>	SA	10	10
Atlantic herring <sup>e</sup>	<i>Clupea harengus</i>	SA	10	10
Beaked redfish <sup>f</sup>	<i>Sebastes mentella</i>	MAF	10	11
Capelin <sup>g</sup>	<i>Mallotus villosus</i>	AS	10	10
Golden redfish	<i>Sebastes marinus</i>	SA	10	11
Greenland halibut <sup>h</sup>	<i>Reinhardtius hippoglossoides</i>	SA	10	10
Haddock <sup>d</sup>	<i>Melanogrammus aeglefinus</i>	SA	10	10
Saithe <sup>d</sup>	<i>Pollachius virens</i>	SA	10	10
<b>GULF OF MAINE, 1967 – 2007</b>				
American plaice	<i>Hippoglossoides platessoides</i>	SBE	12, 13	14
Atlantic cod	<i>Gadus morhua</i>	SBE	12, 13	14
Atlantic halibut	<i>Hippoglossus hippoglossus</i>	SBE	13	14
Atlantic herring	<i>Clupea harengus</i>	SBE	12, 13	14
Atlantic mackerel	<i>Scomber scombrus</i>	SBE	13	14
Atlantic redfishes (ns)	<i>Sebastes fasciatus, Sebastes mentella, Sebastes marinus</i>	SBE	13	14
Atlantic wolffish	<i>Anarhichas lupus</i>	SBE	13	14
Goosefish	<i>Lophius americanus</i>	SBE	12, 13	14
Haddock	<i>Melanogrammus aeglefinus</i>	SBE	12, 13	14
Longfin squid	<i>Loligo pealeii</i>	SBE	13	14
Pollock	<i>Pollachius virens</i>	SBE	12, 13	14
Red hake	<i>Urophycis chuss</i>	SBE	13	14
Shortfin squid	<i>Illex illecebrosus</i>	SBE	13	14
Silver hake	<i>Merluccius bilinearis</i>	SBE	12, 13	14
Skates (ns)	<i>Leucoraja erinacea, Leucoraja ocellata, Raja eglanteria, Malacoraja senta, Amblyraja radiata, Leucoraja ocellata</i>	SBE	13	14
Spiny dogfish	<i>Squalus acanthias</i>	SBE	13	14
White hake	<i>Urophycis tenuis</i>	SBE	13	14
Winter flounder	<i>Pseudopleuronectes americanus</i>	SBE	12, 13	14
Yellowtail flounder	<i>Limanda ferruginea</i>	SBE	12, 13	14
<b>GEORGES BANK, 1967 – 2007</b>				
American plaice	<i>Hippoglossoides platessoides</i>	SBE	12, 13	14
Atlantic butterfish	<i>Peprilus triacanthus</i>	SBE	13	14
Atlantic cod	<i>Gadus morhua</i>	SBE	12, 13	14
Atlantic herring	<i>Clupea harengus</i>	SBE	12, 13	14
Atlantic mackerel	<i>Scomber scombrus</i>	SBE	13	14
Goosefish	<i>Lophius americanus</i>	SBE	12, 13	14
Haddock	<i>Melanogrammus aeglefinus</i>	SBE	12, 13	14

Longfin squid	<i>Loligo pealeii</i>	SBE	13	14
Pollock	<i>Pollachius virens</i>	SBE	12, 13	14
Red hake	<i>Urophycis chuss</i>	SBE	13	14
Scup	<i>Stenotomus chrysops</i>	SBE	13	14
Shortfin squid	<i>Illex illecebrosus</i>	SBE	13	14
Silver hake	<i>Merluccius bilinearis</i>	SBE	12, 13	14
Skates (ns)	<i>Amblyraja radiata</i> , <i>Leucoraja erinacea</i> , <i>Leucoraja garmani</i> , <i>Leucoraja ocellata</i> , <i>Raja eglanteria</i> , <i>Malacoraja senta</i>	SBE	13	14
Spiny dogfish	<i>Squalus acanthias</i>	SBE	13	14
Summer flounder	<i>Paralichthys dentatus</i>	SBE	13	14
Winter flounder	<i>Pseudopleuronectes americanus</i>	SBE	12, 13	14
Yellowtail flounder	<i>Limanda ferruginea</i>	SBE	12, 13	14
<b>HECATE STRAIT, 1984 – 2009</b>				
Arrowtooth flounder	<i>Reinhardtius stomias</i>	SBE <sub>q=0.38</sub>	15, 16	15
Bocaccio	<i>Sebastes paucispinis</i>	SBE <sub>q=1</sub>	15	15
Butter sole	<i>Isopsetta isolepis</i>	SBE <sub>q=0.6</sub>	15, 16	15
Dover sole	<i>Microstomus pacificus</i>	SBE <sub>q=0.38</sub>	15, 16	15
English sole	<i>Parophrys vetulus</i>	SA	17 <sub>(1984-2007)</sub> 18 <sub>(2008-2009)</sub>	19
Eulachon	<i>Thaleichthys pacificus</i>	SBE <sub>q=1</sub>	15	19
Lingcod	<i>Ophiodon elongatus</i>	SBE <sub>q=0.025</sub>	15, 16	19
Pacific cod	<i>Gadus macrocephalus</i>	SA		
Pacific halibut	<i>Hippoglossus stenolepis</i>	SBE <sub>q=0.6</sub>	15, 16	19
Pacific herring	<i>Clupea pallasii</i>	SA	20 <sub>(1984-2008)</sub> 21 <sub>(2009)</sub>	20 <sub>(1984-2008)</sub> 21 <sub>(2009)</sub>
Petrale sole	<i>Eopsetta jordani</i>	SBE <sub>q=0.38</sub>	15, 16	19
Quillback rockfish	<i>Sebastes maliger</i>	SBE <sub>q=1</sub>	15, 22	19
Rex sole	<i>Glyptocephalus zachirus</i>	SBE <sub>q=0.38</sub>	15, 16	19
Sablefish	<i>Anoplopoma fimbria</i>	SBE <sub>q=1</sub>	15	19
Silvergray rockfish	<i>Sebastes brevispinis</i>	SBE <sub>q=1</sub>	15	19
Skates (ns)	Rajidae ( <i>Raja binoculata</i> )	SBE <sub>q=1</sub>	15	19
Southern rock sole	<i>Lepidopsetta bilineata</i>	SA	18	19
Spiny dogfish	<i>Squalus acanthias</i>	SBE <sub>q=1</sub>	15	19
Walleye pollock	<i>Theragra chalcogramma</i>	SBE <sub>q=1</sub>	15	19
Yellowtail rockfish	<i>Sebastes flavidus</i>	SBE <sub>q=1</sub>	15	19
<b>NEWFOUNDLAND / LABRADOR, 1995 – 2009</b>				
Aesop shrimp	<i>Pandalus montagui</i>	MAF	23	24
American plaice	<i>Hippoglossoides platessoides</i>	MAF	23	24
Atlantic cod	<i>Gadus morhua</i>	MAF	23	24
Atlantic herring	<i>Clupea harengus</i>	MAF	23	24
Atlantic redfishes (ns)	<i>Sebastes</i> spp.	MAF	23	24
Beaked redfish	<i>Sebastes mentella</i>	MAF	23	24
Capelin	<i>Mallotus villosus</i>	MAF	23	24
Golden redfish	<i>Sebastes marinus</i>	MAF	23	24
Greenland halibut	<i>Reinhardtius hippoglossoides</i>	MAF	23	24
Northern prawn	<i>Pandalus borealis</i>	MAF	23	24
Snow crab	<i>Chionoecetes opilio</i>	MAF	23	24
Witch flounder	<i>Glyptocephalus cynoglossus</i>	MAF	23	24
Yellowtail flounder	<i>Limanda ferruginea</i>	MAF	23	24

<b>SOUTHERN GULF OF ST. LAWRENCE, 1980 – 2009</b>				
Alewife	<i>Alosa pseudoharengus</i>	SBE	25 – 29	30
American lobster	<i>Homarus americanus</i>	MAF	25 – 29	30
American plaice	<i>Hippoglossoides platessoides</i>	SBE	25 – 29	30
Atlantic cod	<i>Gadus morhua</i>	SA	25 – 29	30
Atlantic halibut	<i>Hippoglossus hippoglossus</i>	SBE	25 – 29	30
Atlantic herring	<i>Clupea harengus</i>	SBE	25 – 29	30
Atlantic redfishes (ns)	<i>Sebastes</i> spp.	SBE	25 – 29	30
Capelin	<i>Mallotus villosus</i>	SBE	25 – 29	30
Greenland halibut	<i>Reinhardtius hippoglossoides</i>	SBE	25 – 29	30
Haddock	<i>Melanogrammus aeglefinus</i>	SBE	25 – 29	30
Rainbow smelt	<i>Osmerus mordax</i>	SBE	25 – 29	30
Rock crab	<i>Cancer irroratus</i>	MAF	25 – 29	30
Shrimps (ns)	Order Decapoda	MAF	25 – 29	30
Snow crab	<i>Chionoecetes opilio</i>	MAF	25 – 29	30
Spiny dogfish	<i>Squalus acanthias</i>	SBE	25 – 29	30
Toad crabs (ns)	<i>Hyas</i> spp.	MAF	25 – 29	30
White hake	<i>Urophycis tenuis</i>	SBE	25 – 29	30
Winter flounder	<i>Pseudopleuronectes americanus</i>	SBE	25 – 29	30
Witch flounder	<i>Glyptocephalus cynoglossus</i>	SBE	25 – 29	30
Yellowtail flounder	<i>Limanda ferruginea</i>	SBE	25 – 29	30
<b>NORTH SEA, 1963 – 2007</b>				
Atlantic cod	<i>Gadus morhua</i>	SA	31	32, 33
Atlantic herring	<i>Clupea harengus</i>	SA	31	32, 33
Common sole	<i>Solea solea</i>	SA	31	32, 33
European plaice	<i>Pleuronectes platessa</i>	SA	31	32, 33
Haddock	<i>Melanogrammus aeglefinus</i>	SA	31	32, 33
Lesser sandeel	<i>Ammodytes</i> sp.	SA	31	32, 33
Norway pout	<i>Trisopterus esmarkii</i>	SA	31	32, 33
Pollock	<i>Pollachius virens</i>	SA	31	32, 33
Whiting	<i>Merlangius merlangus</i>	SA	31	32, 33

<sup>a</sup>Norwegian spring-spawning, age 3+; <sup>b</sup>Northeast Atlantic stock, (14% of both biomass and landings attributed to the Norwegian Sea); <sup>c</sup>Northeast Atlantic stock, age 1+, (16% of both biomass and landings attributed to the Norwegian Sea); <sup>d</sup>Northeast Arctic, age 3+; <sup>e</sup>Norwegian Spring-spawning, ages 0-2; <sup>f</sup>Age 2+; <sup>g</sup>Age 1+; <sup>h</sup>Age 5+

#### TABLE S1 SOURCES

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Table S2. The years of data available, description, and data sources for the environmental and biological covariates examined for each system.

System	Covariate Description	Years of Data Available	Source
<b>PACIFIC SYSTEMS</b>			
GULF OF ALASKA	Summer average surface water temperature	1960 – 2009	1, 2
	Alaska coastal April freshwater discharge	1960 – 2008	3, 4
EASTERN BERING SEA	Summer average surface water temperature	1960 – 2009	2, 5
	Ice cover index	1979 – 2008	5
HECATE STRAIT	Winter (January – March) average sea surface height (measured at Prince Rupert)	1980 – 2009	6
	Winter (October – March) average surface water temperature (measured at Bonilla Island, Hecate Strait)	1980 – 2009	7
	Biomass index of arrowtooth flounder	1984 – 2009	8
ALL	Pacific Decadal Oscillation	1950 – 2008	5
	Siberian High/Aleutian Low Index	1950 – 2008	5
<b>ATLANTIC SYSTEMS</b>			
NEWFOUNDLAND / LABRADOR	Annual average bottom water temperature	1950 – 2009	9
	Annual average surface water temperature	1950 – 2009	9
	Composite of numerous environmental indices	1950 – 2008	10, 11
	Biomass index of harp seals (stock assessment)	1952 – 2009	12
SOUTHERN GULF OF ST. LAWRENCE	Annual average surface water temperature	1950 – 2009	13, 14
	Fall average water temperature at 60-120 m	1971 – 2009	15
	Biomass abundance of grey seal	1971 – 2009	15
WESTERN SCOTIAN SHELF	Annual average water temperature at 100 m	1960 – 2008	16
	Annual average water temperature at 50 m	1960 – 2008	16
	Annual average surface water temperature	1960 – 2008	16
	Index of water column	1960 – 2008	17

System	Covariate Description	Years of Data Available	Source
	stratification		
	Summer average water temperature at the bottom	1970 – 2009	16
	Grey seal biomass	1970 – 2007	18
EASTERN SCOTIAN SHELF	Annual average water temperature at 100 m	1960 – 2008	16
	Annual average water temperature at 50 m	1960 – 2008	16
	Annual average surface water temperature	1960 – 2008	16
	Index of water column stratification	1960 – 2008	17
	Summer average water temperature at the bottom	1970 – 2009	16
	Grey seal biomass	1970 – 2007	18
GULF OF MAINE	Annual average surface water temperature	1956 – 2009	19, 20
	Abundance index of zooplankton	1977 – 2007	21
GEORGES BANK	Annual average surface water temperature	1956 – 2009	19, 20
	Abundance index of zooplankton	1977 – 2007	21
NORWEGIAN SEA	Annual average surface water temperature	1982 – 2009	22
BARENTS SEA	Index of sea ice cover	1980 – 2006	22
	Annual average water temperature (50-200 m) at the Bjørnøya-Fugløya Section	1979 – 2009	22
	Abundance index of harp seal	1979 – 2009	23, 24
NORTH SEA	Annual average surface water temp	1950-2009	19, 20
	Biomass consumed by non-assessed predators (seabirds, mackerel, rays and others)	1959-2009	25
ALL	North Atlantic Oscillation	1950 – 2009	26
	Atlantic Multidecadal Oscillation	1950 – 2009	27

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Table S3. The parameters of the fitted annual surplus production (ASP) and biomass dynamic models without environmental covariates:  $\alpha$ ,  $\beta$  (linear regression parameters),  $\Phi$  (first-order autoregressive coefficient),  $r$  (population growth rate),  $k$  (equilibrium population size in the absence of catch), and  $B_0$  (initial biomass). See Table 1 in the main article for system abbreviations

System	ASP model parameters			Dynamic model parameters		
	$\alpha$	$\beta$ (*10 <sup>-3</sup> )	$\Phi$	$r$	$k$	$B_0$
EBS	0.29	-0.01	0.78	0.62	21,845	9,469
GOA	0.31	-0.05	1.43	0.23	5,970	5,457
HS <sup>a</sup>	0.26	-0.83	2.37	0.10	446	355
GB	0.00	0.19	-0.11	1.49	693	917
GOM	0.35	-0.21	-1.06	0.27	2,495	2,495
WSS <sup>b</sup>	0.51	-0.25	1.84	0.95	1,586	1,302
ESS <sup>c</sup>	0.74	-0.71	NA	0.95	1,128	1,093
NL	1.02	-0.58	2.18	0.19	7,526	954
GOSL <sup>d</sup>	0.73	-0.33	0.37	0.15	9,000	1,371
NS	0.39	-0.02	0.72	0.31	20,092	1,420
BS	0.58	-0.05	0.73	0.83	8,586	2,158
NORT	1.29	-0.15	1.79	2.48	7,113	6,273

<sup>a</sup> $r$  has an upper bound = 0.95 (dynamic model)

<sup>b</sup> $r$  has an upper bound = 0.95 (dynamic model)

<sup>c</sup>The regression model was fitted without and AR1 term.  $r$  has an upper bound = 0.95

<sup>d</sup> $k$  has an upper bound = 9000 (dynamic model)

Table S4. The parameters of the fitted annual surplus production (ASP) and biomass dynamic models with environmental covariates:  $\alpha$ ,  $\beta$  (linear regression parameters),  $\Phi$  (first-order autoregressive coefficient),  $l$  (time lag between the covariate and the effect in the model),  $\delta$  (effect of the covariate on annual surplus production),  $r_{\text{mean}}$  (population growth rate under average covariate conditions),  $k$  (equilibrium population size in the absence of catch),  $B_0$  (initial biomass), and  $\gamma$  (effect of the covariate on population growth). See Table 1 in the main article for system abbreviations

System	ASP model parameters					Dynamic model parameters				
	$\alpha$	$\beta$ (*10 <sup>-3</sup> )	$\Phi$	$l$	$\delta$	$r_{\text{mean}}$	$k$	$B_0$	$l$	$\gamma$
EBS	0.29	-0.01	0.39	1	-517.3	0.47	22,466	10,500	1	-0.63
GOA	0.19	-0.03	0.44	1	-68.8	0.11	7,564	5,401	5	0.66
HS <sup>a</sup>	0.27	-0.98	0.45	4	-21.3	0.10	292	409	4	-1.48
GB <sup>b</sup>	0.24	-0.12	-	3	-21.1	1.73	684	850	5	0.24
GOM	0.32	-0.17	-	3	21.5	0.26	2,833	638	3	-0.18
WSS	0.51	-0.25	-	1	103.9	0.20	3,300	1,222	0	-0.62
ESS	0.52	-0.45	-	0	56.7	0.41	970	753	0	-1.92
NL	0.87	-0.48	-	1	230.0	0.40	2,103	1,058	1	0.72
NS	0.38	-0.02	0.16	6	638.3	0.43	14,983	4,375	5	0.65
BS	0.39	-0.03	-	5	-893.0	0.68	8,999	3,079	6	0.76
NORT	1.29	-0.15	0.55	0	-513.7	2.68	7,040	6,399	2	-0.12

<sup>a</sup> $r$  has an upper bound = 0.95 (dynamic model)

<sup>b</sup>For the regression model, no covariates were significant at the  $p < 0.10$  level

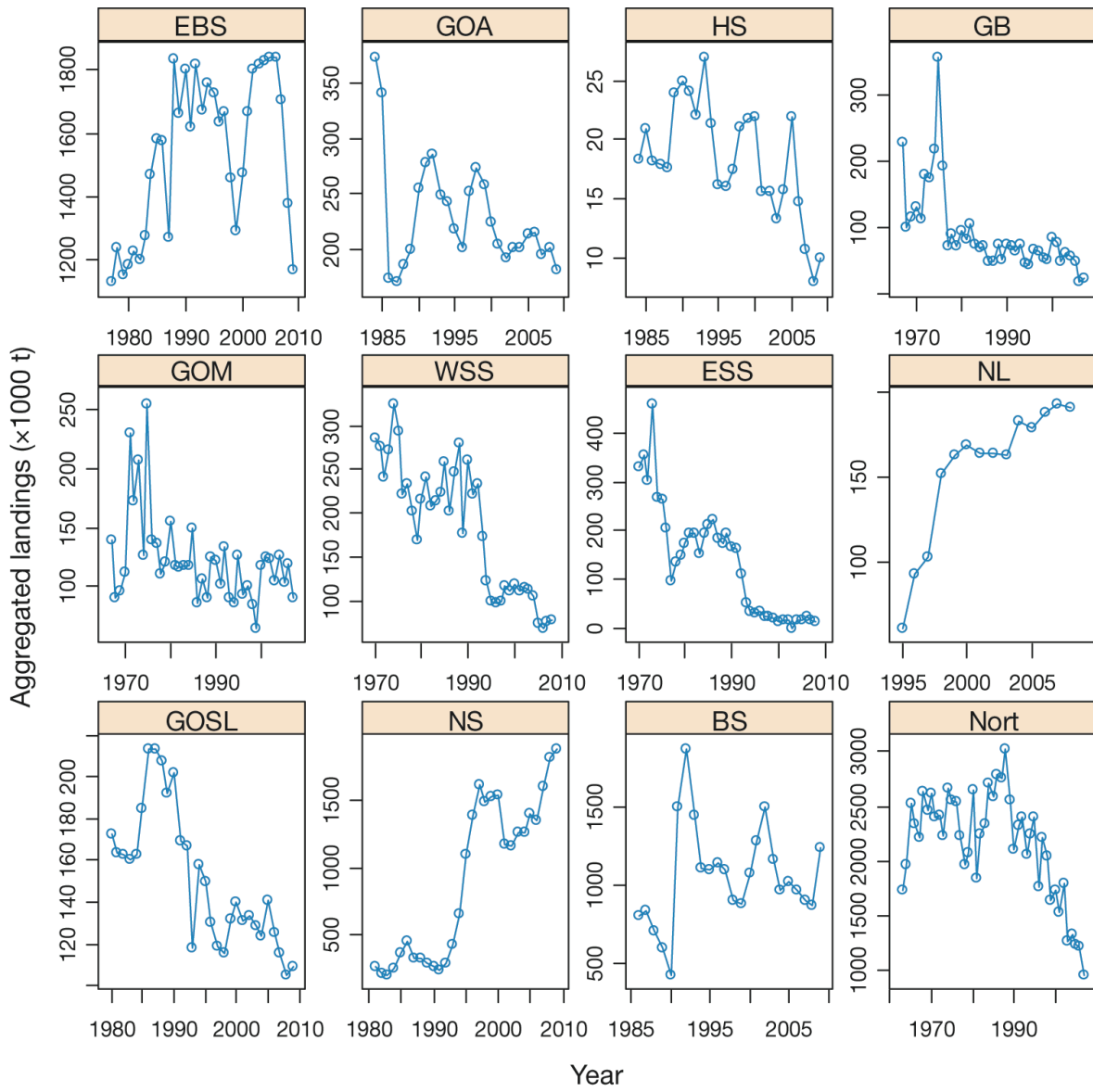


Fig. S1. Total aggregate landings (C,  $\times 1000$  t) in each system. See Table 1 in the main article for system abbreviations

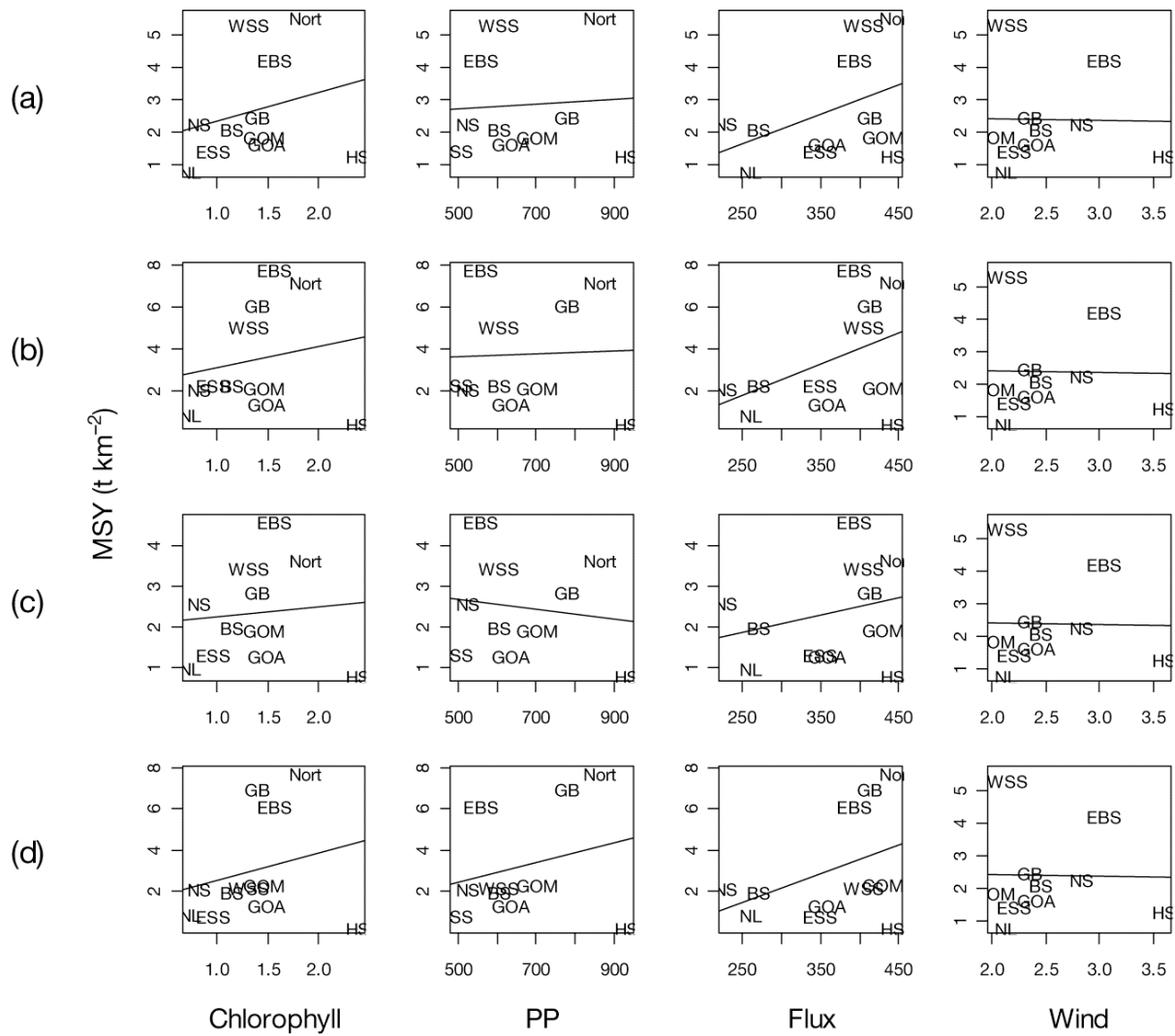


Fig. S2. Bivariate relationships between maximum sustainable yield (MSY) per area vs. 4 different regional characteristics (columns), i.e. chlorophyll concentration, primary production (PP), flux of chlorophyll (Flux), and wind speed (Wind). MSY was calculated in 4 different ways (rows): (a) regression model (no covariate), (b) dynamic model (no covariate), (c) regression model (with covariate), and (d) dynamic model (with covariate). See Table 1 in the main article for system abbreviations.