Supporting Information: Evidence that summer jellyfish blooms impact Pacific Northwest salmon production

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This supplement presents the full parameter set for the Northern California Current (NCC) ECOPATH food web and ECOTRAN end-to-end model. The NCC model was modified from Ruzicka *et al.* (2012). Model parameters (Table S2 - Table S14) are presented as comma-separated format files in zip-compressed folder "NCC_2015_ModelParameters". Column definitions for each Table S2 - Table S14 are described in this supplemental material document. Further information about data sources used to construct the model is available as the supplementary material in Ruzicka *et al.* (2012).

Literature Cited

Ruzicka, J. J., R. D. Brodeur, R. L. Emmett, J. H. Steele, J. E. Zamon, C. A. Morgan, A. C. Thomas, and T. C. Wainwright. 2012. Interannual variability in the Northern California Current food web structure: changes in energy flow pathways and the role of forage fish, euphausiids, and jellyfish. Progress in Oceanography 102:19-41.

Table S1. Northern California Current model: functional groups (See also comma-separated format files S2 - S14 in zip-compressed folder "NCC_2015_ModelParameters")

	functional group	functional group composition
1	NO_3^-	
2	pelagic NH_4^+	
3	benthic NH_4^+	
4	large phytoplankton	$\geq$ 20 μm: large chain & centric diatoms
5	small phytoplankton	< 20 μm: cyanobacteria, dinoflagellates, small diatoms
6	micro-zooplankton	ciliates, flagellate grazers
7	large copepods	$\geq$ 0.025 mg C
8	small copepods	< 0.025 mg C
9	small invertebrate larvae	copepods (nauplii), small crustacean larvae (zoea, cypids), euphausiid (larvae), mollusc larvae (veligers), echinoderm larvae (pluteus), other invert larvae
10	pteropods	
11	pelagic amphipods	hyperiidae, gammaridae
12	pelagic shrimp	Sergestidae, Panaeidae
13	macro-zooplankton	chaetognaths, large crustacean larvae (megalopae), ichthyoplankton, other macro-zooplankton (pelagic polychaetes, heteropods, ostracods, cladocerans)
14	jellyfish: small net-feeders	urochordates (larvaceans, salps)
15	jellyfish: small carnivores	ctenophores, misc. small medusae
16	jellyfish: large carnivores	primarily sea nettle (*Chrysaora fuscescens*), but also small contributions from moon jelly (*Aurelia labiata*), egg yolk (*Phacellophora camtschatica*), water jelly (*Aequorea* spp.), & lion's mane (*Cyanea capillata*)
17	euphausiids: *E. pacifica*	*Euphausia pacifica* (adult & juveniles)
18	euphausiids: *T. spinifera*	*Thysanoessa spinifera* (adult & juveniles)
19	small squid	market squid (*Loligo opalescens*)
20	large squid	Humboldt squid (*Dosidicus gigas*)
21	smelt aggregate	jacksmelt/silversides (*Atherinopsis californiensis*), eulachon (*Thaleichthys pacificus*), night smelt (*Spirinchus starksi*), longfin smelt (*Spirinchus thaleichthys*), surf smelt (*Hypomesus pretiosus*), whitebait smelt (Allosmerus elongates), popeye blacksmelt (*Bathylagus ochotensis*), sandlance (*Ammodytes hexapterus*)
22	shad	shad (*Alosa sapidissima*)
23	Pacific sardine	Pacific sardine (*Sardinops sagax*)
24	Pacific herring	Pacific herring (*Clupea pallasii*)
25	Northern anchovy	Northern anchovy (*Engraulis mordax*)
26	Pacific saury	Pacific saury (*Cololabis saira*)
27	yearling coho salmon	(*Oncorhynchus kisutch*)
28	subyearling Chinook salmon	(*Oncorhynchus tshawytscha*)
29	yearling Chinook salmon	(*Oncorhynchus tshawytscha*)
30	other juvenile salmon	juveniles: pink (*Oncorhynchus gorbuscha*), chum (*Oncorhynchus keta*), sockeye (*Oncorhynchus nerka*), steelhead (*Oncorhynchus mykiss*)
31	mesopelagic fish	Myctophidae, Bathylagidae, Lophotidae (Crestfishes), Ophidiidae (cusk eel), Paralepididae (barracudina), Stomiidae (dragonfish), Trachipteridae (ribbonfishes), Nemichthyidae (snipe eels)

	functional group	functional group composition
32	rockfish: planktivores	aurora (*Sebastes aurora*), bank (*S. rufus*), blue (*S. mystinus*), darkblotched (*S. crameri*), greenstriped (*S. elongates*), harlequin (*S. variegatus*), Pacific ocean perch (*S. alutus*), Puget Sound (*S. emphaeus*), pygmy (*S. wilsoni*), redstripe (*S. proriger*), rosy (*S. rosaceus*), sharpchin (*S. zacentrus*), shortbelly (*S. jordani*), splitnose (*S. diploproa),* stripetail (*S. saxicola*), widow (*S. entomelas*), yellowmouth (*S. reedi*)
33	coho salmon	adults: (*Oncorhynchus kisutch*)
34	Chinook salmon	adults: (*Oncorhynchus tshawytscha*)
35	other salmon	adults: pink (*Oncorhynchus gorbuscha*), chum (*Oncorhynchus keta*), sockeye (*Oncorhynchus nerka*), steelhead (*Oncorhynchus mykiss*) , cutthroat trout (*Oncorhynchus mykiss*)
36	sharks	thresher (*Alopias vulpinus*), soupfin (*Galeorhinus galeus*), salmon (*Lamna ditropis*), blue (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*)
37	jack mackerel	jack mackerel (*Trachurus symmetricus*)
38	Pacific mackerel	Pacific mackerel (*Scomber japonicas*)
39	rockfish: piscivores	black (*Sebastes melanops*), blackgill (*S. melanostomus*), bocaccio (*S. paucispinis*), canary (*S. pinniger*), chilipepper (*S. goodie*), yelloweye (*S. ruberrimus*), yellowtail (*S. flavidus*)
40	dogfish aggregate	spiny dogfish (*Squalus acanthias*), brown catshark (*Apristurus brunneus*), filetail catshark (*Parmaturus xaniurus*), Pacific sleeper shark (*Somniosus pacificus*)
41	Pacific hake	Pacific hake (*Merluccius productus*)
42	tuna aggregate	albacore (*Thunnus alalunga*), Pacific barracuda (*Sphyraena argentea*), bigeye tuna (*Thunnus obesus*), bluefin tuna (*Thunnus thynnus*), Bramidae (pomfret), Carangidae (jacks, pompanos), yellowtail tuna (*Thunnus albacares*), Pacific bonito (*Sarda chiliensis*)
43	sablefish	sablefish (*Anoplopoma fimbria*)
44	hexagrammids	lingcod (*Ophiodon elongates*), greenling (*Hexagrammos decagrammus*)
45	flatfish: piscivores	Pacific halibut (*Hippoglossus stenolepis*), arrowtooth flounder (*Atheresthes stomias*), petrale sole (*Eopsetta jordani*), California halibut (*Paralichthys californicus*)
46	skates & rays	bat ray (*Myliobatis californica*), Bering skate (*Beringraja binoculata*), big skate (*Raja binoculata*), black skate (*Bathyraja trachura*), Pacific electric ray (*Torpedo californica*), longnose skate (*Raja rhina*), Pacific angelshark (*Squatina californica*), spotted ratfish (*Hydrolagus colliei*)
47	small benthic fish	Agonidae (poachers), Bathymasteridae (ronquils), Batrachoididae (Toadfishes), Blenniidae (blennies), Cottidae (sculpins), Cyclopteridae (lumpfish), Embiotocidae (surfperch), Gasterosteidae (sticklebacks), Gobiidae (gobies), hagfish, Kyphosidae (sea chubs), lamprey eels, Liparidae (snailfish), Moronidae (striped bass), Pholidae (gunnels), prowfish, Sciaenidae (drums, croakers), Stichaeidae (prickleback), Syngnathidae (pipefishes), Triglidae (Searobins), Zoarcidae (eelpout)
48	rockfish: benthivores	cabezon (*Scorpaenichthys marmoratus*), China (*Sebastes nebulosus*), copper (*Sebastes caurinus*), longspine thornyhead (*Sebastolobus altivelis*), quillback (*Sebastes maliger)*, redbanded (*Sebastes babcocki*), rosethorn (*Sebastes helvomaculatus*), rougheye (*Sebastes aleutianus*), shortraker (*Sebastes borealis*), shortspine thornyhead (*Sebastolobus alascanus*), silvergray (*Sebastes brevispinis*), tiger (*Sebastes nigrocinctus*)
49	gadids	Pacific cod (*Gadus macrocephalus*), walleye pollock (*Theragra chalcogramma*), Pacific tomcod (*Microgadus proximus*)
50	flatfish: benthivores	English sole (*Parophrys vetulus*), Dover sole (*Microstomus pacificus*), rex sole (*Glyptocephalus zachirus*)

	functional group	functional group composition
51	flatfish: misc. small	butter sole (*Isopsetta isolepis*), curlfin sole (*Pleuronichthys decurrens*), deepsea sole (*Embassichthys bathybius*), flathead sole (*Hippoglossoides elassodon*), rock sole (*Lepidopsetta bilineata*), sand sole (*Trulla capensis*), sanddabs (*Citharichthys* spp.), slender sole (*Lyopsetta exilis*), starry flounder (*Platichthys stellatus*), Pleuronectidae (turbot)
52	grenadier	giant grenadier (*Albatrossia pectoralis*), Pacific grenadier (*Coryphaenoides acrolepis*)
53	juvenile fish: rockfish	
54	juvenile fish: osteichthys	
55	juvenile fish: chondrichthys	
56	infauna	
57	Pandalid shrimp	pink shrimp (*Pandalus jordani*)
58	epifauna: epibenthic shrimp	(*Crangon* spp.), (*Callianassa* spp.)
59	epifauna: mysids	mysids & cumaceans
60	epifauna: echinoderms	red sea urchin (*Mesocentrotus franciscanus*), purple sea urchin (*Strongylocentrotus purpuratus*), misc. brittle stars, misc. sea cucumbers, (NOTE: does not include starfish)
61	epifauna: misc. crustaceans	benthic amphipods, isopods, cumaceans
62	bivalves	basket cockle (*Clinocardium nuttallii*), butter clam (*Saxidomus gigantean*), California mussel (Mytilus californianus), gaper clam (*Tresus capax*), Manila clam (*Venerupis philippinarum*), native littleneck clam (*Leukoma staminea*), rock scallop (*Crassadoma gigantean*), Weathervane scallops (*Patinopecten caurinus*), Pacific oyster (*Crassostrea gigas*), razor clam (*Siliqua patula*), soft-shelled clam (*Mya arenaria*), purple varnish clam (*Nuttallia obscurata*), rough paddock (*Zirfaea pilsbryi*), flat tipped piddock (*Penitella penita*)
63	epifauna: suspension feeders	barnacles, bryozoans, sea anemones
64	epifauna: Dungeness crab	Dungeness crab (*Cancer magister*)
65	epifauna: Tanner crab	Tanner crab (*Chionoecetes bairdi*)
66	epifauna: misc. carnivores	misc. small crabs, misc. gastropods, starfishes
67	sooty shearwaters	sooty shearwaters (*Puffinus griseus*)
68	common murre	common murre (*Uria aalge*)
69	gulls & terns	California gull (*Larus californicus*), glaucous-winged gull (*L. glaucescens*), Heermann's gull (*L.s heermanni*), herring gull (*L. argentatus*), ring-billed gull (*L. delawarensis*), Sabine's gull (*Xema sabini*), western gull (*L. occidentalis*), hybrid gulls, arctic tern (*Sterna paradisaea*), Caspian tern (*Sterna caspia*), common tern (*S. hirundo*)
70	alcids	Cassin's auklet (*Ptychoramphus aleuticus*), rhinoceros auklet (*Cerorhinca monocerata*), pigeon guillemot (*Cepphus columba*), marbled murrelet (*Brachyramphus marmoratus*), ancient murrelet (*Synthliboramphus antiquus*), tufted puffin (*Fratercula cirrhata*), horned puffin (*F. corniculata*)
71	large pelagic seabirds	black-footed albatross (*Phoebastria nigripes*), Laysan albatross (*Phoebastria immutabilis*), parasitic jaeger (*Stercorarius parasiticus*), northern fulmar (*Fulmarus glacialis*), skuas, petrels
72	other pelagic seabirds	Buller's shearwater (*Puffinus bulleri*), flesh-footed shearwater (*Puffinus carneipes*), pink-footed shearwater (*Puffinus creatopus*), red-necked Phalarope (*Phalaropus lobatus*), misc. murres (not common muure)

	functional group	functional group composition
73	coastal seabirds (divers)	brown pelican (*Pelecanus occidentalis*), white pelican (*Pelecanus erythrorhynchos*), Brandt's cormorant (*Phalacrocorax penicillatus*), double-crested cormorant (*Phalacrocorax auritus*), pelagic cormorant (*Phalacrocorax pelagicus*), western grebe (*Aechmophorus occidentalis*), Clark's grebe (*Aechmophorus clarkii*)
74	storm-petrels	fork-tailed storm petrel (*Oceanodroma furcata*), Leach's storm-petrel (*Oceanodroma leucorhoa*)
75	gray whales	gray whales (*Eschrichtius robustus*)
76	baleen whales	minke whale (*Balaenoptera acutorostrata*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*), fin whale (*Balaenoptera physalus*), blue whale (*Balaenoptera musculus*)
77	small pinnipeds	harbor seal (*Phoca vitulina richardsi*), northern fur seal (*Callorhinus ursinus*)
78	large pinnipeds	California sea lion (*Zalophus californicus*), steller sea lion (*Eumetopias jubatus*), northern elephant seal (*Mirounga angustirostris*)
79	small toothed whales	harbor porpoise (*Phocoena phocoena*), Dall's porpoise (*Phocoenoides dalli*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), Risso's dolphin (*Grampus griseus*), northern right whale dolphin (*Lissodelphis borealis*)
80	large toothed whales	sperm whale (*Physeter catadon*), pilot whale (*Globicephala macrorhynchus*), Baird's beaked whale (*Berardius bairdii*), mesoplodon beaked whale (*Mesoplodon* spp.), Cuvier's beaked whale (*Ziphius cavirostris*)
81	killer whales	killer whales (*Orcinus orca*)
82	invertebrate eggs	
83	fish eggs	
84	pelagic detritus	
85	fishery offal	
86	benthic detritus	
87	fishery: longline	longline, setline
88	fishery: troll gear	troll gear
89	fishery: bottomfish troll gear	bottomfish troll gear
90	fishery: hook+line	jig, hook & line gear
91	fishery: offshore hook+line	commercial troll, setline, (NOTE: does not include troll gear)
92	fishery: trawls	groundfish trawl gear, (NOTE: excludes shrimp trawls & hake fishery)
93	fishery: shrimp trawls	shrimp trawls, beam trawls
94	fishery: pelagic net gear	set net, dip net
95	fishery: midwater trawls	midwater trawls in hake fishery
96	fishery: gill nets	gill net, drift gill net
97	fishery: seine	seine net
98	fishery: fish pot	fish pot
99	fishery: crab & lobster pot	crab & lobster pot
100	fishery: other pot & trap	prawn trap, other trap gear
101	fishery: diving	diving gear
102	fishery: other gear	dredge gear, other gear
103	fishery: recreational	recreational fishing

Table S2. NCC ECOPATH parameters. By column (values of -9999 represent empty cells):
 1. group number code,
 2. TL (trophic level),
 3. b (biomass),
 4. (p/b) (biomass-specific production rate),
 5. (q/b) (biomass-specific consumption rate),
 6. (p/q) (production-to-consumption ratio = production efficiency),
 7. ee (ecotrophic efficiency),
 8. egf (egestion fraction of consumption).

Table S3. NCC fishery gear type group composition. By column (values of -9999 represent empty cells):
 1. group number code,
 2. fishery code,
 3. fishery name,
 4. gear type composition,
 5. TL (trophic level),

Table S4. NCC ECOPATH parameters, fishery landings (t WWT km^{-2} y^{-1}). By column (values of -9999 represent empty cells):
 1. fishery letter code,
 2. group name,
 3 - 19. fishery (by code A - Q)

Table S5. NCC ECOPATH parameters, fishery discard (t WWT km^{-2} y^{-1}). By column (values of -9999 represent empty cells):
 1. fishery letter code,
 2. group name,
 3 - 19. fishery (by fishery number letter code A - Q)

Table S6 NCC ECOPATH parameters: Fate of unconsumed production (1 - *ee*) to gametes and to detritus pools, as fractions of total unconsumed production. By column (values of -9999 represent empty cells):
 1. group number code,
 2. group name,
 3. invertebrate eggs,
 4. fish eggs,
 5. pelagic detritus,
 6. fishery offal,
 7. benthic detritus,
 8. export

Table S7. NCC ECOPATH: Diet matrix D_{cp}; fraction of total diet, by wet weight, of each prey type p (listed down rows) eaten by each consumer group c (listed across columns). By column (values of -9999 represent empty cells):
1. group number code,
2. group name,
3 - 80. Predator (by group number code 4 - 81)

Table S8. NCC ECOTRAN parameters: Fate of egested detritus, senescent detritus, and metabolized biomass as fractions of production. NOTE: fishery discards are defined as "feces". NOTE: "metabolism" of detritus groups is used to define the fate of excretion by bacteria that metabolize detritus. By column (values of -9999 represent empty cells):
1. group number code,
2. group name,
3. egestion (surface)
4. egestion (sub-surface)
5. senescence (surface)
6. senescence (sub-surface)
7. metabolized (surface)
8. metabolized (sub-surface)

Table S9. NCC ECOTRAN: trophic network matrix A_{cp} showing fate of all consumption by each functional group as percentages. Producers p run across columns. Flow to consumers c, metabolism, and detritus run down rows. By column (values of -9999 represent empty cells):
1. group number code,
2. group name,
3 - 102. Consumer (by group number code 1 - 103)

Table S10. NCC ECOPATH: defined uncertainty levels for physiological parameters (Coefficient of Variation, CV). By column (values of -9999 represent empty cells):
1. group number code,
2. group name,
3. b (biomass),
4. (p/b) (biomass-specific production rate),
5. (q/b) (biomass-specific consumption rate),
6. (p/q) (production-to-consumption ratio = production efficiency),
7. egf (egestion fraction of consumption).

Table S11. NCC ECOPATH: defined uncertainty levels for fishery landings (Coefficient of Variation, CV). By column (values of -9999 represent empty cells):
1. fishery letter code,
2. group name,
3 - 19. fishery (by code A - Q)

Table S12. NCC ECOPATH: defined uncertainty levels for fishery discards (Coefficient of Variation, CV). By column (values of -9999 represent empty cells):

      1. fishery letter code,

      2. group name,

      3 - 19. fishery (by code A - Q)

Table S13. NCC ECOPATH: defined uncertainty levels for diet matrix (Coefficient of Variation, CV). By column (values of -9999 represent empty cells):

      1. group number code,

      2. group name,

      3 - 80. Predator (by group number code 4 - 81)

Table S14. NCC ECOPATH: prey guild groups for Monte Carlo-generated diet matrices. For each randomly generated diet matrix, predator diet compositions are re-apportioned among these prey guilds, weighted by each (randomly generated) prey production rate. By column:

      1. prey guild name,

      2. prey guild (by group number code)