

The following supplement accompanies the article

Marine connectivity: a new look at pelagic larval duration and genetic metrics of dispersal

K. A. Selkoe^{1,2,*}, Robert J. Toonen¹

¹Hawai'i Institute of Marine Biology, University of Hawai'i, Kāne'ohe, Hawaii 97644, USA

²National Center for Ecological Analysis and Synthesis, 735 State St., Santa Barbara, California 93101, USA

*Email: selkoe@nceas.ucsb.edu

Marine Ecology Progress Series 436:291–305 (2011)

Row	Study Region	Notes:
1	Great Barrier Reef	
2	China	Deep split north vs south so used IBD from north only (Fig 2b)
3	Pacific Ocean	Used IBD from lower cluster of sampled populations
4	N. Atlantic	Used 15 locus set (excludes one locus under clear selection)
5	Baltic Sea	
6	N.W. Atlantic	
7	Caribbean	
8	Coral Triangle	
9	Coral Triangle	
10	Coral Triangle	
11	Coral Triangle	
12	S.E. Europe	Diversity shows gaussian distrib across latitude - see fig 2
13	N.E. Pacific	
14	Coral Triangle	
15	Indonesia	Black clade fig 5a only
16	Tropical Pacific	Averaged 3 FST values for 3 regions showing IBD within them
17	Pacific Ocean	IBD within island chains (excludes between chain pairs)
18	California	
19	W. Pacific and GBR	Excluded African samples
20	Great Barrier Reef	High FIS values
21	Scotland	
22	Philippines	
23	Europe	IBD excludes Tenerife and Wadden Sea
24	Hawaii	
25	Hawaii	
26	Hawaii	
27	Caribbean	IBD present at <1000 km only
28	Europe	Excluded Cape Verde (may be different species)
29	N. France	An invasive since 1940
30	France	Recent invader
31	Norway	
32	Nova Scotia	
33	Caribbean	IBD results for Panama samples (6-16)
34	N. France	
35	Europe	
36	California	
37	Ireland	May have latitudinal cline in allelic richness
38	Iberia	
39	Europe	
40	Mediterranean	
41	N.E. Australia	
42	Gulf Mexico	
43	U.S. west coast	
44	U.S. west coast	
45	Caribbean	IBD only in one subregion of 4
46	Mediterranean	
47	Red Sea	IBD only seen at small scale (10 km)
48	Indo-pacific Ocean	FST values not available, expressed as migrants
49	N.W. Atlantic	
50	Eastern US	
51	Sweden	
52	Mediterranean	
53	New Zealand	
54	N. America west coast	
55	Ryukyus	Some asexuality; genotypes:indivs was 0.67
56	Atlantic/Caribbean	
57	Australia	Easter group only; Pelsaert group showed IBD
58	Europe	
59	Europe	IBD at large scale driven by outlier pops. No IBD at small scale
60	Australia	
61	Caribbean	IBD at small scale, not at large
62	Mediterranean	
63	Mediterranean	
64	Caribbean	
65	Skagerrak	
66	Australia	
67	California	
68	Alaska	
69	N.W. Atlantic	
70	California/Mexico	
71	California	
72	S.E. U.S.	
73	Europe	
74	U.K.	
75	hawaii	
76	Global	
77	Europe	
78	N.E. Pacific	
79	California/Mexico	
80	California/Mexico	
81	Australia	
82	Caribbean	
83	China	
84	Philippines	Slight ibd at largest scale. No ibd at intermediate scales for 2 sections of coastline
85	Global	

Selkoe & Toonen Appendix Bibliography

- Alberto F, Raimondi PT, Reed DC, Coelho NC, Leblois R, Whitmer A, Serrao EA (2010) Habitat continuity and geographic distance predict population genetic differentiation in giant kelp. *Ecology* 91:49-56
- Aurelle D, Guillemaud T, Afonso P, Morato T, Wirtz P, Santos RS, Cancela ML (2003) Genetic study of *Coris julis* (Osteichthyes, Perciformes, Labridae) evolutionary history and dispersal abilities. *C R Biol* 326:771-785
- Banks SC, Piggott MP, Williamson JE, Bove U, Holbrook NJ, Beheregaray LB (2007) Oceanic variability and coastal topography shape genetic structure in a long-dispersing sea urchin. *Ecology* 88:3055-3064
- Bay LK, Caley MJM, Crozier RH (2008a) Meta-population structure in a coral reef fish demonstrated by genetic data on patterns of migration, extinction and re-colonisation. *BMC Evol Biol* 8:Article No.: 248
- Bay LK, Caley MJM, Crozier RH (2008b) Meta-population structure in a coral reef fish demonstrated by genetic data on patterns of migration, extinction and re-colonisation. *BMC Evol Biol* 8
- Bay LK, Choat JH, van Herwerden L, Robertson DR (2004) High genetic diversities and complex genetic structure in an Indo-Pacific tropical reef fish (*Chlorurus sordidus*): evidence of an unstable evolutionary past? *Mar Biol* 144:757-767
- Beacham TD, Bratley J, Miller KM, Le KD, Withler RE (2002) Multiple stock structure of Atlantic cod (*Gadus morhua*) off Newfoundland and Labrador determined from genetic variation. *ICES J Mar Sci* 59:650-665
- Benzie JAH, Williams ST (1997) Genetic structure of giant clam (*Tridacna maxima*) populations in the west Pacific is not consistent with dispersal by present-day ocean currents. *Evolution* 51:768-783
- Billot C, Engel CR, Rousvoal S, Kloareg B, Valero M (2003) Current patterns, habitat discontinuities and population genetic structure: the case of the kelp *Laminaria digitata* in the English Channel. *Mar Ecol Prog Ser* 253:111-121
- Bird CE, Holland BS, Bowen BW, Toonen RJ (2007) Contrasting phylogeography in three endemic Hawaiian limpets (*Cellana* spp.) with similar life histories. *Mol Ecol* 16:3173-3186
- Cabranes C, Fernandez-Rueda P, Martinez JL (2008) Genetic structure of *Octopus vulgaris* around the Iberian Peninsula and Canary Islands as indicated by microsatellite DNA variation. *ICES J Mar Sci* 65:12-16
- Carreras-Carbonell J, Macpherson E, Pascual M (2006) Population structure within and between subspecies of the Mediterranean triplefin fish *Tripterygion delaisi* revealed by highly polymorphic microsatellite loci. *Mol Ecol* 15:3527-3539
- Charrier G, Durand JD, Quiniou L, Laroche J (2006) An investigation of the population genetic structure of pollack (*Pollachius pollachius*) based on microsatellite markers. *ICES J Mar Sci* 63:1705-1709
- Costantini F, Fauvelot C, Abbiati M (2007) Genetic structuring of the temperate gorgonian coral (*Corallium rubrum*) across the western Mediterranean Sea revealed by microsatellites and nuclear sequences. *Mol Ecol* 16:5168-5182
- Couceiro L, Barreiro R, Ruiz JM, Sotka EE (2007) Genetic isolation by distance among populations of the netted dog whelk *Nassarius reticulatus* (L.) along the European Atlantic coastline. *J Hered* 98:603-610
- Craig MT, Eble JA, Bowen BW, Robertson DR (2007) High genetic connectivity across the Indian and Pacific Oceans in the reef fish *Myripristis berndti* (Holocentridae). *Mar Ecol Prog Ser* 334:245-254

- Curley BG, Gillings MR (2009) Population connectivity in the temperate damselfish *Parma microlepis*: analyses of genetic structure across multiple spatial scales. *Mar Biol* 156:381-393
- DeBoer TS, Subia MD, Ambariyanto, Erdmann MV, Kovitvongsa K, Barber PH (2008) Phylogeography and Limited Genetic Connectivity in the Endangered Boring Giant Clam across the Coral Triangle. *Conserv Biol* 22:1255-1266
- Diaz-Ferguson E, Haney R, Wares J, Silliman B (2010) Population Genetics of a Trochid Gastropod Broadens Picture of Caribbean Sea Connectivity. *Plos One* 5
- Domingues CP, Creer S, Taylor MI, Queiroga H, Carvalho GR (2010) Genetic structure of *Carcinus maenas* within its native range: larval dispersal and oceanographic variability. *Mar Ecol Prog Ser* 410:111-123
- Dupont L, Ellien C, Viard F (2007) Limits to gene flow in the slipper limpet *Crepidula fornicata* as revealed by microsatellite data and a larval dispersal model. *Mar Ecol Prog Ser* 349:125-138
- Francisco SM, Castilho R, Soares M, Congiu L, Brito A, Vieira MN, Almada VC (2009) Phylogeography and demographic history of *Atherina presbyter* (Pisces: Atherinidae) in the North-eastern Atlantic based on mitochondrial DNA. *Mar Biol* 156:1421-1432
- Galindo-Sanchez CE, Gaffney PM, Perez-Rostro CI, De La Rosa-Velez J, Candela J, Cruz P (2008) Assessment of genetic diversity of the eastern oyster *Crassostrea virginica* in Veracruz, Mexico using microsatellite markers. *J Shellfish Res* 27:721-727
- Gold JR, Turner TF (2002) Population structure of red drum (*Sciaenops ocellatus*) in the northern Gulf of Mexico, as inferred from variation in nuclear-encoded microsatellites. *Mar Biol* 140:249-265
- Gomez-Uchida D, Banks MA (2005) Microsatellite analyses of spatial genetic structure in darkblotched rockfish (*Sebastes crameri*): Is pooling samples safe? *Can J Fish Aquat Sci* 62:1874-1886
- Gruenthal KM, Burton RS (2008) Genetic structure of natural populations of the California black abalone (*Haliotis cracherodii* Leach, 1814), a candidate for endangered species status. *J Exp Mar Biol Ecol* 355:47-58
- Haig JA, Connolly RM, Hughes JM (2010) Little shrimp left on the shelf: the roles that sea-level change, ocean currents and continental shelf width play in the genetic connectivity of a seagrass-associated species. *J Biogeogr* 37:1570-1583
- Hellberg ME (1996) Dependence of gene flow on geographic distance in two solitary corals with different larval dispersal capabilities. *Evolution* 50:1167-1175
- Johansson ML, Banks MA, Glunt KD, Hassel-Finnegan HM, Buonaccorsi VP (2008) Influence of habitat discontinuity, geographical distance, and oceanography on fine-scale population genetic structure of copper rockfish (*Sebastes caurinus*). *Mol Ecol* 17:3051-3061
- Johnson MS, Black R (1995) NEIGHBORHOOD SIZE AND THE IMPORTANCE OF BARRIERS TO GENE FLOW IN AN INTERTIDAL SNAIL. *Heredity* 75:142-154
- Karlsson S, Saillant E, Gold JR (2009) Population structure and genetic variation of lane snapper (*Lutjanus synagris*) in the northern Gulf of Mexico. *Marine Biology (Berlin)* 156:1841-1855
- Keeney DB, King TM, Rowe DL, Poulin R (2009) Contrasting mtDNA diversity and population structure in a direct-developing marine gastropod and its trematode parasites. *Mol Ecol* 18:4591-4603
- Kenchington EL, Harding GC, Jones MW, Prodohl PA (2009) Pleistocene glaciation events shape genetic structure across the range of the American lobster, *Homarus americanus*. *Mol Ecol* 18:1654-1667
- Kenchington EL, Patwary MU, Zouros E, Bird CJ (2006) Genetic differentiation in relation to marine landscape in a broadcast-spawning bivalve mollusc (*Placopecten magellanicus*). *Mol Ecol* 15:1781-1796
- Knutsen H, Jorde PE, Andre C, Stenseth NC (2003) Fine-scaled geographical population structuring in a highly mobile marine species: the Atlantic cod. *Mol Ecol* 12:385-394

- Kochzius M, Nuryanto A (2008) Strong genetic population structure in the boring giant clam, *Tridacna crocea*, across the Indo-Malay Archipelago: implications related to evolutionary processes and connectivity. *Mol Ecol* 17:3775-3787
- Launey S, Ledu C, Boudry P, Bonhomme F, Naciri-Graven Y (2002) Geographic structure in the European flat oyster (*Ostrea edulis* L.) as revealed by microsatellite polymorphism. *J Hered* 93:331-338
- Lessios HA, Kane J, Robertson DR (2003) Phylogeography of the pantropical sea urchin *Tripneustes*: Contrasting patterns of population structure between oceans. *Evolution* 57:2026-2036
- Lourie SA, Green DM, Vincent ACJ (2005) Dispersal, habitat differences, and comparative phylogeography of Southeast Asian seahorses (*Syngnathidae* : *Hippocampus*). *Mol Ecol* 14:1073-1094
- Maier E, Tollrian R, Rinkevich B, Nurnberger B (2005) Isolation by distance in the scleractinian coral *Seriatopora hystrix* from the Red Sea. *Mar Biol* 147:1109-1120
- Makinen T, Panova M, Johannesson K, Tatarenkov A, Appelqvist C, Andre C (2008) Genetic differentiation on multiple spatial scales in an ecotype-forming marine snail with limited dispersal: *Littorina saxatilis*. *Biol J Linn Soc* 94:31-40
- Marko PB (2004) 'What's larvae got to do with it?' Disparate patterns of post-glacial population structure in two benthic marine gastropods with identical dispersal potential. *Mol Ecol* 13:597-611
- McInerney CE, Allcock AL, Johnson MP, Prodohl PA (2009) Understanding marine reserve function in a seascape genetics context: *Nucella lapillus* in Strangford Lough (Northern Ireland) as an example. *Aquatic Biology* 7:45-58
- Miller-Sims VC, Gerlach G, Kingsford MJ, Atema J (2008) Dispersal in the spiny damselfish, *Acanthochromis polyacanthus*, a coral reef fish species without a larval pelagic stage. *Mol Ecol* 17:5036-5048
- Nielsen JL, Graziano SL, Seitz AC (2010) Fine-scale population genetic structure in Alaskan Pacific halibut (*Hippoglossus stenolepis*). *Conserv Genet* 11:999-1012
- Nishikawa A, Katoh M, Sakai K (2003) Larval settlement rates and gene flow of broadcast-spawning (*Acropora tenuis*) and planula-brooding (*Stylophora pistillata*) corals. *Mar Ecol Prog Ser* 256:87-97
- Nobrega R, Sole-Cava AM, Russo CAM (2004) High genetic homogeneity of an intertidal marine invertebrate along 8000 km of the Atlantic coast of the Americas. *J Exp Mar Biol Ecol* 303:173-181
- Perez-Portela R, Villamor A, Almada V (2010) Phylogeography of the sea star *Marthasterias glacialis* (Asteroidea, Echinodermata): deep genetic divergence between mitochondrial lineages in the north-western mediterranean. *Mar Biol* 157:2015-2028
- Piggott MP, Banks SC, Tung P, Beheregaray LB (2008) Genetic evidence for different scales of connectivity in a marine mollusc. *Mar Ecol Prog Ser* 365:127-136
- Pinsky ML, Montes HR, Palumbi SR (2010) Using isolation by distance and effective density to estimate dispersal scales in anemonefish. *Evolution* 64:2688-2700
- Planes S, Fauvelot C (2002) Isolation by distance and vicariance drive genetic structure of a coral reef fish in the Pacific Ocean. *Evolution* 56:378-399
- Pogson GH, Taggart CT, Mesa KA, Boutilier RG (2001) Isolation by distance in the Atlantic cod, *Gadus morhua*, at large and small geographic scales. *Evolution* 55:131-146
- Puebla O, Bermingham E, Guichard F (2009) Estimating dispersal from genetic isolation by distance in a coral reef fish (*Hypoplectrus puella*). *Ecology* 90:3087-3098
- Purcell JFH, Cowen RK, Hughes CR, Williams DA (2006) Weak genetic structure indicates strong dispersal limits: a tale of two coral reef fish. *Proc R Soc Lond, Ser B: Biol Sci* 273:1483-1490

- Purcell JFH, Cowen RK, Hughes CR, Williams DA (2009) Population structure in a common Caribbean coral-reef fish: implications for larval dispersal and early life-history traits. *J Fish Biol* 74:403-417
- Ravago-Gotanco RG, Magsino RM, Juinio-Menez MA (2007) Influence of the North Equatorial Current on the population genetic structure of *Tridacna crocea* (Mollusca : Tridacnidae) along the eastern Philippine seaboard. *Mar Ecol Prog Ser* 336:161-168
- Rios C, Sanz S, Saavedra C, Pena JB (2002) Allozyme variation in populations of scallops, *Pecten jacobaeus* (L.) and *P. maximus* (L.) (Bivalvia : Pectinidae), across the Almeria-Oran front. *J Exp Mar Biol Ecol* 267:223-244
- Rocha LA, Bass AL, Robertson DR, Bowen BW (2002) Adult habitat preferences, larval dispersal, and the comparative phylogeography of three Atlantic surgeonfishes (Teleostei : Acanthuridae). *Mol Ecol* 11:243-252
- Rose CG, Paynter KT, Hare MP (2006) Isolation by distance in the eastern oyster, *Crassostrea virginica*, in Chesapeake Bay. *J Hered* 97:158-170
- Selkoe KA, Watson JR, White C, Horin T and others (2010) Taking the chaos out of genetic patchiness: seascape genetics reveals ecological and oceanographic drivers of genetic patterns in three temperate reef species. *Mol Ecol* 19:3708-3726
- Simon-Bouhet B, Garcia-Meunier P, Viard F (2006) Multiple introductions promote range expansion of the mollusc *Cyclope neritea* (Nassariidae) in France: evidence from mitochondrial sequence data. *Mol Ecol* 15:1699-1711
- Skarstein TH, Westgaard JI, Fevolden SE (2007) Comparing microsatellite variation in north-east Atlantic cod (*Gadus morhua* L.) to genetic structuring as revealed by the pantophysin (Pan I) locus. *J Fish Biol* 70:271-290
- Stamatis C, Triantafyllidis A, Moutou KA, Mamuris Z (2004) Mitochondrial DNA variation in northeast atlantic and mediterranean populations of norway lobster, *Nephrops norvegicus*. *Mol Ecol* 13:1377-1390
- Tatarenkov A, Jonsson RB, Kautsky L, Johannesson K (2007) Genetic structure in populations of *Fucus vesiculosus* (Phaeophyceae) over spatial scales from 10 m to 800 km. *J Phycol* 43:675-685
- Todd CD, Lambert WJ, Thorpe JP (1998) The genetic structure of intertidal populations of two species of nudibranch molluscs with planktotrophic and pelagic lecithotrophic larval stages: are pelagic larvae "for" dispersal? *J Exp Mar Biol Ecol* 228:1-28
- Watts PC, Thorpe JP (2006) Influence of contrasting larval developmental types upon the population-genetic structure of cheilostome bryozoans. *Mar Biol* 149:1093-1101
- Weetman D, Hauser L, Bayes MK, Ellis JR, Shaw PW (2006) Genetic population structure across a range of geographic scales in the commercially exploited marine gastropod *Buccinum undatum*. *Mar Ecol Prog Ser* 317:157-169
- White C, Selkoe KA, Watson JR, Siegel DA, Zacherl DC, Toonen RJ (2010a) Ocean currents help explain population genetic structure. *Proceedings of the Royal Society B-Biological Sciences* in press:doi:10.1098/rspb.2009.2214
- White TA, Stamford J, Hoelzel AR (2010b) Local selection and population structure in a deep-sea fish, the roundnose grenadier (*Coryphaenoides rupestris*). *Mol Ecol* 19:216-226
- Xia JH, Huang JH, Gong JB, Jiang SG (2008) Significant population genetic structure of yellowfin seabream *Acanthopagrus latus* in China. *J Fish Biol* 73:1979-1992
- Yang J, Li Q, Kong L, Zheng X, Wang R (2008) Genetic structure of the veined rapa whelk (*Rapana venosa*) populations along the coast of China. *Biochem Genet* 46:539-548
- Yasuda N, Nagai S, Hamaguchi M, Okaji K, Gerard K, Nadaoka K (2009) Gene flow of *Acanthaster planci* (L.) in relation to ocean currents revealed by microsatellite analysis. *Mol Ecol* 18:1574-1590

Zulliger DE, Tanner S, Ruch M, Ribi G (2009) Genetic structure of the high dispersal Atlanto-Mediterranean sea star *Astropecten aranciatus* revealed by mitochondrial DNA sequences and microsatellite loci. *Mar Biol* 156:597-610