

The following supplement accompanies the article

Intertidal invertebrate harvesting: a meta-analysis of impacts and recovery in an important waterbird prey resource

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Table S1. Preferred prey and winter habitat of common bird species in the intertidal. Adapted from Goss-Custard et al. (2006).

Species	Preferred Prey Genus	Preferred Winter Habitat	References
Bar-tailed Godwit <i>Limosa lapponica</i>	<i>Scrobicularia</i> <i>Macoma</i> <i>Hediste</i> ¹ <i>Arenicola</i>	Tidal sand and muddy-sand flats in intertidal estuaries. Associated with more exposed bays and estuaries.	Johnsgard (1981), del Hoyo et al. (1996), Goss-Custard et al. (2006).
Black-tailed Godwit <i>Limosa limosa</i>	<i>Scrobicularia</i> <i>Macoma</i> <i>Hediste</i> ¹ <i>Crangon</i>	Subspecies <i>limosa</i> favours freshwater wintering habitats, while <i>islandica</i> winters on intertidal mudflats in sheltered bays and estuaries. Favours muddier sites than <i>L. lapponica</i> which winters in sandier areas.	Johnsgard (1981), del Hoyo et al. (1996), Goss-Custard et al. (2006).
Eurasian Curlew <i>Numenius arquata</i>	<i>Mya</i> <i>Cerastoderma</i> <i>Scrobicularia</i> <i>Macoma</i> <i>Hediste</i> ¹ <i>Arenicola</i> <i>Carcinus</i>	Sheltered mud and sandflats in coastal areas and estuaries.	Johnsgard (1981), del Hoyo et al. (1996), Goss-Custard et al. (2006).

Species	Preferred Prey Genus	Preferred Winter Habitat	References
Eurasian Oystercatcher <i>Haematopus ostralegus</i>	<i>Mytilus</i> <i>Mya</i> <i>Cerastoderma</i> <i>Scrobicularia</i> <i>Macoma</i> <i>Hediste</i> ¹ <i>Arenicola</i> <i>Carcinus</i>	Widespread in coastal areas including rocky and sandy shores, commonly winters on estuarine mud and sandflats and areas of saltmarsh. Favours sandier habitats over finer sediments.	Johnsgard (1981), Goss-Custard et al. (1992), del Hoyo et al. (1996), Goss-Custard et al. (2006).
Common Redshank <i>Tringa totanus</i>	<i>Mya</i> <i>Scrobicularia</i> <i>Macoma</i> <i>Hydrobia</i> <i>Corophium</i> <i>Hediste</i> ¹ <i>Carcinus</i> <i>Crangon</i>	Various coastal habitats although mainly estuaries and coastal lagoons where they are most associated with sheltered tidal mudflats.	Johnsgard (1981), del Hoyo et al. (1996), Goss-Custard et al. (2006).
Dunlin <i>Calidris alpina</i>	<i>Scrobicularia</i> <i>Macoma</i> <i>Hydrobia</i> <i>Corophium</i> <i>Hediste</i> ¹	Estuarine and coastal tidal flats. Prefers muddier sites.	Johnsgard (1981), del Hoyo et al. (1996), Goss-Custard et al. (2006).
Red Knot <i>Calidris canutus</i>	<i>Mytilus</i> <i>Mya</i> <i>Cerastoderma</i> <i>Scrobicularia</i> <i>Macoma</i> <i>Hydrobia</i> <i>Hediste</i> ¹	Sheltered coasts, tidal mud and sandflats. Sheltered sandy beaches.	Johnsgard (1981), del Hoyo et al. (1996), Goss-Custard et al. (2006).
Grey Plover <i>Pluvialis squatarola</i>	<i>Scrobicularia</i> <i>Macoma</i> <i>Hydrobia</i> <i>Hediste</i> ¹ <i>Arenicola</i>	Intertidal mudflats, sandflats and saltmarsh in coastal areas, sheltered bays and estuaries	Johnsgard (1981), del Hoyo et al. (1996), Goss-Custard et al. (2006).

Species	Preferred Prey Genus	Preferred Winter Habitat	References
Ringed Plover <i>Charadrius hiaticula</i>	<i>Hydrobia</i> <i>Corophium</i> <i>Hediste</i> ¹	Sandy and gravel shores and tidal mud and sandflats.	Johnsgard (1981), del Hoyo et al. (1996), Goss-Custard et al. (2006).
Sanderling <i>Calidris alba</i>	<i>Crangon</i> <i>Nerine</i> <i>Bathyporeia</i> <i>Eurydice</i>	Sandy beaches on open exposed coastlines.	Johnsgard (1981), Brearey, (1982) del Hoyo et al. (1996), Goss-Custard et al. (2006).
Common Shelduck <i>Tadorna tadorna</i>	<i>Hydrobia</i> <i>Macoma</i> <i>Corophium</i> <i>Nereis</i> ¹	Muddy and sandy coastlines and tidal flats.	Olney, (1965), Johnsgard (1981), del Hoyo et al. (1996), Goss-Custard et al. (2006).

¹ Along with other polychaete worms

Table S1 References

Brearey DM (1982) The feeding ecology and foraging behaviour of sanderling *Calidris alba* and turnstone *Arenaria interpres* at Teesmouth NE England. PhD dissertation, Durham University, UK

del Hoyo J, Elliott A, Sargatal J (1999) Handbook of the birds of the world. Vol. 5. Lynx Edicions, Barcelona

Goss-Custard JD, West AD, Yates MG, Caldow RWG, Stillman RA, Bardsley L, Castilla J, Castro M, Dierschke V, dit Durell SE, Eichhorn G, Ens BJ, Exo KM, Udayangani-Fernando PU, Ferns PN, Hockey PAR, Gill JA, Johnstone I, Kalejta-Summers B, Masero JA, Moreira F, Nagarajan RV, Owens IPF, Pacheco C, Perez-Hurtado A, Rogers D, Scheiffarth G, Sitters H, Sutherland WJ, Triplet P, Worrall DH, Zharikov Y, Zwarts L, Pettifor RA (2006) Intake rates and the functional response in shorebirds (Charadriiformes) eating macro-invertebrates. *Biol Rev* 81:501-529

Johnsgard PA (1981) The plovers, sandpipers, and snipes of the world. University of Nebraska Press

Olney P (1965) The food and feeding habits of Shelduck *Tadorna tadorna*. *Ibis* 107:527-532

Table S2. Publications included in the analysis, indicating the region, gears employed and the year of study

Publication	Region	Habitats	Gears	Year
Brown B, Wilson WH (1997) The role of commercial digging of mudflats as an agent for change of infaunal intertidal populations. <i>J Exp Mar Biol Ecol</i> 218:49-61	Walpole, Maine, USA	Mudflats	Hand Digging	1993
Carvalho S, Constantino R, Cerqueira M, Pereira F, Subida MD, Drake P, Gaspar MB (2013) Short-term impact of bait digging on intertidal macrobenthic assemblages of two south Iberian Atlantic systems. <i>Estuar Coast Shelf Sci</i> 132:65-76	Iberian Peninsula, Southern Spain	Intertidal flats, saltmarsh	Hand Digging	2009
Castaldelli G, Mantovani S, Welsh DT, Rossi R, Mistri M, Fano E (2003) Impact of commercial clam harvesting on water column and sediment physicochemical characteristics and macrobenthic community structure in a lagoon (Sacca di Goro) of the Po River Delta. <i>Chem Ecol</i> 19:161-171	Po River Delta, Italy	Sandflat (sandy-silt sediment)	Hand Raking ("Rasca")	2000
Clarke S, Tully O (2014) BACI monitoring of effects of hydraulic dredging for cockles on intertidal benthic habitats of Dundalk Bay, Ireland. <i>J Mar Biol Assoc UK</i> 94:1451-1464	Dundalk Bay, Ireland	Sandflats	Hydraulic Dredge	2009-2010
Cotter A, Walker P, Coates P, Cook W, Dare P (1997) Trial of a tractor dredger for cockles in Burry Inlet, South Wales. <i>ICES J Mar Sci</i> 54:72-83	Burry Inlet, UK	Sandflats	Mechanical Tractor Dredge	1992
Dernie KM, Kaiser MJ, Warwick RM (2003) Recovery Rates of Benthic Communities Following Physical Disturbance. <i>J Anim Ecol</i> 72:1043-1056	Anglesey, North Wales	Sand and mud flats (clean sand; silty sand; sandy mud; mud)	Hand Digging	2001
Ferns PN, Rostron DM, Siman HY (2000) Effects of mechanical cockle harvesting on intertidal communities. <i>J Appl Ecol</i> 37:464-474	Burry Inlet, UK	Intertidal muddy sand; Intertidal clean sand	Mechanical Tractor Dredge	1992
Hall SJ, Harding MJC (1997) Physical Disturbance and Marine Benthic Communities: The Effects of Mechanical Harvesting of Cockles on Non-Target	Solway Firth, UK	Mudflats	Hydraulic Dredge; Mechanical Tractor	1993

Publication	Region	Habitats	Gears	Year
Benthic Infauna. J Appl Ecol 34:497-517			Dredge	
Kaiser MJ, Edwards DB, Spencer BE (1996) Infaunal community changes as a result of commercial clam cultivation and harvesting. Aquat Living Resour 9:57-63	Whitstable, UK	Mudflat	Suction Dredge	1994-1995
Kaiser MJ, Broad G, Hall SJ (2001) Disturbance of intertidal soft-sediment benthic communities by cockle hand raking. J Sea Res 45:119-130	Dee Estuary, UK	Silty intertidal sandflat	Hand Raking	1996
Lenihan H, Micheli F (2000) Biological effects of shellfish harvesting on oyster reefs: resolving a fishery conflict by ecological experimentation. Fish Bull 98:86-95	North Carolina, USA	Sandy to muddy intertidal channels	Hand Raking and Tongs	1996
McLusky D, Anderson F, Wolfe-Murphy S (1983) Distribution and population recovery of <i>Arenicola marina</i> and other benthic fauna after bait digging. Mar Ecol Prog Ser 11:173-179	Forth Estuary, UK	Intertidal mudflat	Hand Digging	1980; 1981
Skilleter GA, Zharikov Y, Cameron B, McPhee DP (2005) Effects of harvesting callianassid (ghost) shrimps on subtropical benthic communities. J Exp Mar Biol Ecol 320:133-158	Moreton Bay, Queensland, Australia	Estuarine intertidal sandflat	Hand Pump ("Yabbie")	1996
Spencer BE, Kaiser MJ, Edwards DB (1998) Intertidal clam harvesting: benthic community change and recovery. Aquac Res 29:429-437	River Exe, UK	Intertidal muddy sand	Suction Dredge	1991-1995
Whomersley P, Huxham M, Bolam S, Schratzberger M, Augley J, Ridland D (2010) Response of intertidal macrofauna to multiple disturbance types and intensities – an experimental approach. Mar Environ Res 69:297-308	Forth Estuary, UK; Crouch Estuary, UK	Mudflats	Hand Raking	2003
Wynberg RP, Branch GM (1994) Disturbance associated with bait-collection for sandprawns (<i>Callinassa kraussi</i>) and mudprawns (<i>Upogebia africana</i>): long-term effects on the biota of intertidal sandflats. J Mar Res 52:523-558	Langebaan Lagoon, South Africa	Sandflats	Hand Digging, Hand Pump	1988

Table S3. Publications not included in the analysis, indicating rationale for exclusion

Publication	Exclusion Rationale
Brylinsky M, Gibson J, Gordon Jr DC (1994) Impacts of Flounder Trawls on the Intertidal Habitat and Community of the Minas Basin, Bay of Fundy. <i>Can J Fish Aquat Sci</i> 51:650-661	Gear used (flounder trawl) is unique with regards to intertidal fishing and as far as the authors are aware is limited to the Bay of Fundy. Therefore not a representative intertidal harvesting method.
Dernie K, Kaiser M, Richardson E, Warwick R (2003) Recovery of soft sediment communities and habitats following physical disturbance. <i>J Exp Mar Biol Ecol</i> 285:415-434	Significant outlier in analysis. Large bias and therefore excluded.
Stagnol D, Renaud M, Davoult D (2013) Effects of commercial harvesting of intertidal macroalgae on ecosystem biodiversity and functioning. <i>Estuar Coast Shelf Sci</i> 130:99-110	Harvesting carried out in rocky intertidal habitats. Not representative.
Godcharles MF (1971) A study of the effects of a commercial hydraulic clam dredge on benthic communities in estuarine areas. Florida Dept. of Natural Resources Technical Series No. 64	Cannot obtain full text
Glude JB, Landers WS (1953) Biological effects on hard clams of hand raking and power dredging, Vol 110. US Department of the Interior, Fish and Wildlife Service	No usable data.
Boldina I, Beninger PG (2014) Fine-scale spatial distribution of the common lugworm <i>Arenicola marina</i> , and effects of intertidal clam fishing. <i>Estuar Coast Shelf Sci</i> 143:32-40	No usable data.
Watson GJ, Farrell P, Stanton S, Skidmore LC (2007) Effects of bait collection on <i>Nereis virens</i> populations and macrofaunal communities in the Solent, UK. <i>J Mar Biol Assoc UK</i> 87:703-716	No usable data. Data reported not traceable to sampling method.
Simenstad CA, Fresh KL (1995) Influence of intertidal aquaculture on benthic communities in Pacific Northwest estuaries: scales of disturbance. <i>Estuaries</i> 18:43-70	Study investigates addition of gravel for aquaculture rather than harvesting. Not relevant to our study aims.
Moreno CA, Sutherland JP, Jara HF (1984) Man as a predator in the intertidal zone of southern Chile. <i>Oikos</i> 42:155-160	No usable data.
Fiordelmondo C, Manini E, Gambi C, Pusceddu A (2003) Short-term impact of clam harvesting on sediment chemistry, benthic microbes and meiofauna in the Goro lagoon (Italy). <i>Chem Ecol</i> 19:173-187	No relevant responses reported.
Cook W (1991) Studies on the effects of hydraulic dredging on cockle and other macroinvertebrate populations 1989-1990. North Western and North Wales Sea Fisheries Committee.	Cannot obtain full text.
de Boer WF, van Schie AM, Jocene DF, Mabote AB, Guissamulo A (2001) The impact of artisanal fishery on a tropical intertidal benthic fish community. <i>Environ Biol Fishes</i> 61:213-229	No usable data. Experimental design unclear.

Publication	Exclusion Rationale
Cryer M, Whittle GN, Williams R (1987) The impact of bait collection by anglers on marine intertidal invertebrates. Biol Conserv 42:83-93	No variance reported.
Pickett G (1973) The impact of mechanical harvesting on the Thames Estuary cockle fishery. Laboratory Leaflet No. 29. Ministry of Agriculture, Fisheries and Food	No usable data.
van den Heiligenberg T (1987) Effects of mechanical and manual harvesting of lugworms <i>Arenicola marina</i> L. on the benthic fauna of tidal flats in the Dutch Wadden Sea. Biol Conserv 39:165-177	No variance reported.
Beukema J (1995) Long-term effects of mechanical harvesting of lugworms <i>Arenicola marina</i> on the zoobenthic community of a tidal flat in the Wadden Sea. Neth J Sea Res 33:219-227	No variance reported.
Park SR, Kim YK, Kim J-H, Kang C-K, Lee K-S (2011) Rapid recovery of the intertidal seagrass <i>Zostera japonica</i> following intense Manila clam (<i>Ruditapes philippinarum</i>) harvesting activity in Korea. J Exp Mar Biol Ecol 407:275-283	Response only reported for <i>Zostera japonica</i> . Not relevant for research question.
Piersma T, Koolhaas A, Dekinga A, Beukema JJ, Dekker R, Essink K (2001) Long-Term Indirect Effects of Mechanical Cockle-Dredging on Intertidal Bivalve Stocks in the Wadden Sea. J Appl Ecol 38:976-990	Sample size unclear.