

Increased use of intertidal resources benefits breeding success in a generalist gull species

Nina J. O’Hanlon*, Rona A. R. McGill, Ruedi G. Nager

*Corresponding author: nina.ohanlon@uhi.ac.uk

Marine Ecology Progress Series 574: 193–210 (2017)

Table S1. Timing of visits in the study colonies to collect pellets and make observations on brood sizes in (A) 2013 and (B) 2014.

Table S1A. Dates of colony visits during the 2013 breeding season.

Copeland	Islay	Jura	Lady Isle	Oronsay	Pladda	Portpatrick	Strangford
16/05/2013	12/05/2013	28/05/2013	07/05/2013	16/05/2013	04/05/2013	09/05/2013	06/05/2013
19/05/2013	13/05/2013	29/05/2013		17/05/2013	21/05/2013	23/05/2013	22/05/2013
01/06/2013	14/05/2013	09/07/2013		18/05/2013	31/05/2013	02/06/2013	03/06/2013
02/06/2013	15/05/2013			19/05/2013	01/06/2013	03/06/2013	18/06/2013
08/06/2013	26/05/2013			10/06/2013	17/06/2013	04/06/2013	
09/06/2013	27/05/2013			11/06/2013	18/06/2013	05/06/2013	
15/06/2013	28/05/2013			12/06/2013	19/06/2013	15/06/2013	
16/06/2013	30/05/2013			13/06/2013	01/07/2013	16/06/2013	
29/06/2013	31/05/2013			14/06/2013	02/07/2013	04/07/2013	
	06/06/2013			23/06/2013	03/07/2013	05/07/2013	
	07/06/2013			24/06/2013	04/07/2013	06/07/2013	
	08/06/2013			25/06/2013	17/07/2013	15/07/2013	
	09/06/2013			26/06/2013	18/07/2013	16/07/2013	
	13/06/2013			27/06/2013	19/07/2013		
	17/06/2013			10/07/2013	22/07/2013		
	20/06/2013			11/07/2013			
	21/06/2013			12/07/2013			
	22/06/2013			13/07/2013			
	07/07/2013			14/07/2013			
	08/07/2013						

Table S1B. Dates of colony visits during the 2014 breeding season.

Copeland	Islay	Jura	Lady Isle	Oronsay	Pladda	Portpatrick	Strangford
10/05/2014	05/05/2014	19/05/2014	13/05/2014	03/06/2014	02/05/2014	01/05/2014	14/05/2014
11/05/2014	10/05/2014		24/05/2014	04/06/2014	17/05/2014	05/05/2014	09/06/2014
23/05/2014	18/05/2014		30/05/2014	05/06/2014	27/05/2014	15/05/2014	11/06/2014
09/06/2014	26/05/2014		11/06/2014	06/06/2014	31/05/2014	08/06/2014	12/06/2014
14/06/2014	27/05/2014		18/06/2014	07/06/2014	01/06/2014	09/06/2014	25/06/2014
15/06/2014	28/05/2014		26/06/2014	15/06/2014	06/06/2014	10/06/2014	26/06/2014
28/06/2014	29/05/2014		15/07/2014	16/06/2014	07/06/2014	20/06/2014	
29/06/2014	03/06/2014			17/06/2014	15/06/2014	21/06/2014	
02/07/2014	04/06/2014			18/06/2014	20/06/2014	22/06/2014	
	06/06/2014			01/07/2014	28/06/2014	23/06/2014	
	08/06/2014			02/07/2014	29/06/2014		
	11/06/2014			03/07/2014	10/07/2014		
	16/06/2014			04/07/2014			
	17/06/2014			13/07/2014			
	18/06/2014						
	19/06/2014						
	20/06/2014						
	23/06/2014						
	25/06/2014						
	27/06/2014						
	28/06/2014						
	29/06/2014						
	30/06/2014						
	03/07/2014						
	07/07/2014						

Table S2. Breeding success based on all active nests (including total nest failure) and mean brood size of nests where the chicks reached at least three weeks of age

Total number of nests	Brood size from all nests	Brood size from successfully hatched nests	Year	Location	Reference
249	1.29	1.46	1963	Sandy Point South, New England	Kadlec & Drury 1968
121	1.47	1.65	1963	Sandy Point North, New England	Kadlec & Drury 1968
44	1.09	1.5	1963	Coatue, New England	Kadlec & Drury 1968
275	1.02	1.52	1963	Block Island, New England	Kadlec & Drury 1968
258	0.93	0.98	1965	Block Island, New England	Kadlec & Drury 1968
266	1.42	1.47	1966	Block Island, New England	Kadlec & Drury 1968
36	0.75	1.5	1970	Skokholm, Wales	Davis 1974
366	0.6	1.9	1970	Skokholm, Wales	Davis 1975
224	0.63	1.7	1972	Skokholm, Wales	Davis 1975
223	1.25	1.55	1976	Great Island, Newfoundland	Pierotti 1982
297	1.63	1.98	1977	Great Island, Newfoundland	Pierotti & Annett 1991
332	1.83	2.09	1978	Great Island, Newfoundland	Pierotti & Annett 1991
335	1.3	1.74	1983-1988	Trerebon, France	Pons 1992
63	0.51	1.33	1989	Trerebon, France	Pons 1992
26	0.5	1.86	1992	Terschelling, Netherlands	Bukacińska et al. 1996
41	2.37	2.69	1997	Walney, England	R.G. Nager unpub. data
84	1.43	1.65	1998	Walney, England	R.G. Nager unpub. data

Table S3. Nutritional information on food items consumed by herring gulls within this study (taken from the literature).
*energy density estimated from pDM: James et al. 2012.

Food type	Mass (g)	Energy density kJ/g wet weight	Protein (%)	Lipid (%)	Water (%)	Reference
Terrestrial						
Grain	0.07	0.24	11.80	0.00	87.10	Heuzé et al. 2016
Terrestrial invertebrates						
earthworm	0.20	2.96	10.50	1.60	83.60	Finke 2002
cricket	0.47	5.87	20.50	6.80	69.20	Finke 2002
Mammal (adult house mouse)	-	7.18	18.20	7.70	67.30	Dierenfeld et al. 2002
Bird (chicken, one day old)	-	6.21	16.60	5.70	74.40	Dierenfeld et al. 2002
Refuse						
chicken	-	1.22	21.39	3.08	75.46	USDA 2016
beef	-	5.59	10.91	26.13	55.31	USDA 2016
pork	-	1.26	20.65	17.55	74.97	USDA 2016
chips	-	6.87	3.49	14.04	43.19	USDA 2016
raw potato	-	0.67	2.05	0.09	79.25	USDA 2016
bacon	-	2.29	28.31	2.78	62.50	USDA 2016
sausages	-	3.57	13.60	14.3	60.50	USDA 2016
white bread	-	6.01	10.66	2.15	39.60	USDA 2016
Intertidal						
Crab, <i>Carcinus maenas</i>	-	0.16*	12.30	0.20	68.00	Fulton & Fairchild 2013
<i>Mytilus edulis</i>	1.00	0.30	11.90	2.20	-	Ciancio et al. 2007
<i>Littorina littorina</i>	0.25	0.33	-	-	-	Chambers & Milne 1979
Marine offshore						
Cod	131.00	4.20	16.10	2.60	78.50	Lawson et al. 1998
Nephrops	-	3.68	14.30	1.30	74.20	Björnsson et al. 2004

Literature cited

- Björnsson B, Álvaro M, Dombaxe D (2004) Quality of Nephrops as food for Atlantic cod (*Gadus morhua* L.) with possible implications for fisheries management. ICES J Mar Sci 61:983–991.
- Bukacińska M, Bukaciński D, Spaans AL (1996) Attendance and diet in relation to breeding success in Herring Gulls (*Larus argentatus*). Auk 113:300–309.
- Chambers MR, Milne H (1979) Seasonal variation in the condition of some intertidal invertebrates of the Ythan Estuary, Scotland. Estuar Coast Mar Sci 8:411–419.
- Ciancio JE, Pascual MA, Beauchamp DA (2007) Energy density of Patagonian aquatic organisms and empirical predictions based on water content. Trans Am Fish Soc 136:1415–1422.
- Davis. JWF (1974) Herring gull population and man. Nat Wales 14:85–90.
- Davis JWF (1975) Age, egg-size and breeding success in the herring gull *Larus argentatus*. Ibis 117:460–473.
- Dierenfeld ES, Alcorn HL, Jacobsen KL (2002) Nutrient Composition of Whole Vertebrate Prey. http://www.rodentpro.com/qpage_articles_03.asp. Accessed 18 Dec 2016
- Finke MD (2002) Complete nutrient composition of commercially raised invertebrates used as food for insectivores. Zoo Biol 21:269–285.
- Fulton BA, Fairchild EA (2013) Nutritional analysis of whole Green Crab, *Carcinus maenas*, for application as a forage fish replacement in Agrifeeds. Sustain Agric Res 2:126–135.
- Heuzé V, Tran G, Nozière P, Noblet J, Renaudeau D, Lessire M, Lebas F (2016) Barley grain. In: Feedipedia by INRA, CIRAD, AFZ FAO. <http://www.feedipedia.org/node/227>. Accessed 18 Dec 2016
- James DA, Csargo IJ, Eschen A Von, et al (2012) A generalized model for estimating the energy density of invertebrates. Freshw Sci 31:69–77.
- Kadlec JA, Drury WH (1968) Structure of the New England Herring Gull population. Ecology 49:644–676.
- Lawson JW, Magalhaes AM, Millerv EH (1998) Important prey species of marine vertebrate predators in the northwest Atlantic: proximate composition and energy density. Mar Ecol Prog Ser 164:13–20.
- Pierotti R (1982) Habitat selection and its effect on reproductive output in the Herring Gull in Newfoundland. Ecology 63:854–868.
- Pierotti R, Annett CA (1991) Diet choice in the Herring Gull: constraints imposed by reproductive and ecological factors. Ecology 72:319–328.
- Pons M (1992) Effects of change in the availability of human refuse on breeding parameters in a herring gull *Larus argentatus* population in Brittany, France. Ardea 80:143–150.
- USDA (2016) USDA Food Composition Databases. In: United States Dep. Agric. Agric. Res. Serv.