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Baseline

Opportunistic sampling to quantify plastics in the diet of unfledged Black Legged Kittiwakes (*Rissa tridactyla*), Northern Fulmars (*Fulmarus glacialis*) and Great Cormorants (*Phalacrocorax carbo*)

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ABSTRACT

Seabirds can interact with marine litter, mainly by entanglement or ingestion. The ingestion of plastics can lead to starvation or physical damage to the digestive tract. For chicks, it could additionally lead to reduced growth, affecting survival and fledging. This study quantified the ingestion of plastics by seabird chicks via an opportunistic sampling strategy. When ringing is carried out at colonies, birds may spontaneously regurgitate their stomach contents due to the stress or as a defence mechanism. Regurgitates were collected from nestlings of three different species: Black-legged Kittiwake (*Rissa tridactyla*, n = 38), Northern Fulmar (*Fulmarus glacialis*, n = 14) and Great Cormorant (*Phalacrocorax carbo*, n = 28). Plastic was present in all species, with the highest frequency of occurrence (FO) in Northern Fulmar chicks (28.6%), followed by Black-legged Kittiwakes (7.9%) and Great Cormorants (7.1%). The observed load of plastics on chicks, which have not yet left the nest, highlights the pervasive nature of plastic pollution.

Marine litter has been recognised as a threat to wildlife and the marine environment (Bergmann et al., 2015; Derraik, 2002; Gall and Thompson, 2015). Kühn et al. (2015) report that 557 species, including 50% of all seabird species, are affected by marine litter. Seabirds are affected by marine litter through two main ways: ingestion and entanglement. Ingestion can block an animal's digestive tract, cause ulcers or perforations, produce a false satiation feeling, causing the bird not to feed, leading to impairment or starvation (Derraik, 2002; Ryan, 1988a, 1988b). There are also possible effects originating from compounds either added to plastics during production processes or adsorbed by them when drifting at sea (Koelmans, 2015; Tanaka et al., 2015). Entanglement can cause injuries or trap animals, impairing their ability to search for food (Laist, 1997), or if used in nest construction, ensnare young and prevent them from fledging (Bond et al., 2012; Lavers et al., 2013).

Ingestion of plastic debris has been widely reported globally for adult seabirds (Avery-Gomm et al., 2013; Gall and Thompson, 2015; Kühn et al., 2015; Provencher et al., 2016; Provencher et al., 2014; Roman et al., 2016; Van Franeker and Law, 2015), but there has been fewer reports in the peer-reviewed literature for chicks (Bond et al., 2010; Carey, 2011; Cousin et al., 2015; Rodríguez et al., 2012; Ryan, 1988a, 1988b), except for albatross chicks, which have high levels of plastic litter in their digestive tract and have been extensively studied (Sievert and Sileo, 1993; Sileo et al., 1990; Young et al., 2009). Chicks are not able to feed by themselves, so they receive their food from their parents, in many species via regurgitation. Chick survival can be dependent on a range of factors including: predation, thermal stress and, food availability. The fact that seabirds are long lived species, with delayed sexual maturity, that lay small clutch sizes compounds the potential impact that an additional threat, such as plastic litter could have on seabird populations.

Dietary studies through the collection of expelled boluses and spontaneous regurgitation are minimally invasive, and yet can provide an insight into the presence/absence of plastic litter in 'healthy' seabirds, as opposed to beached birds and carcasses found in breeding colonies (Hammer et al., 2016; Lindborg et al., 2012). During the course of demographic research activities such as ringing, many birds spontaneously regurgitate stomach contents as a response to the stress of being handled or as a defence mechanism. Regurgitation does not always expel the entire stomach contents, sometimes permitting that only the upper stomach contents to be expelled (Barrett et al., 2007; Bond and Lavers, 2013). However, regurgitates provide an opportunity to sample the diet of seabirds in situ and alive, as opposed to laboratory experiments and the examination of carcasses. Understanding trends in

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Table 1
Regurgitate sample description per species ordered by year of collection and location.

Species	Year	Regurgitates (n)	Location
Great Cormorant (*Phalacrocorax carbo*)	2011	25	St. Patrick's, Co. Donegal & Great Saltee, Co. Wexford
	2012	3	Ireland's Eye, Co. Dublin
Great Cormorant total		28	
Black-legged Kittiwake	2013	17	Rockabill, Co. Dublin
(*Rissa tridactyla*)	2015	21	Rockabill, Co. Dublin
Black-legged Kittiwake total		38	
Northern Fulmar (*Fulmarus glacialis*)	2015	14	Great Saltee, Co. Wexford
Northern Fulmar total		14	
Sample total		80	

ingestion of plastic litter by different species has the potential to inform policy and generate mitigation measures.

This study aimed to provide baseline data for the ingestion of plastics by seabird chicks in Ireland. Spontaneous regurgitates were collected at four different breeding colonies during ringing and demographic colony work, from three different species: Black-Legged Kittiwake (*Rissa tridactyla*), Northern Fulmar (*Fulmarus glacialis*) and Great Cormorant (*Phalacrocorax carbo*). Through the examination of chick regurgitates, it is possible to obtain insight into the diet of seabird chicks and how they interact with plastic pollution and, consequently into the same interactions in breeding adults when considering seabird populations in Ireland as a whole.

Regurgitate samples were collected from 80 individuals at four different colonies in the years 2011, 2012, 2013 & 2015 (Table 1) via opportunistic sampling while chicks were ringed in the nest during colony work. Samples were collected in plastic bags and frozen until further analysis. After thawing overnight, each sample was washed through a 1 mm mesh sieve and every solid item retained in petri dishes. Solid contents were air dried overnight and examined under a Stereo microscope (MicrosAustria, 0.6 ×–5 ×). They were separated into food and non-food categories according to Van Franeker et al. (2003). Litter items were weighed to the nearest 0.0001 g and food items were identified and counted.

Statistical analysis was carried out using R studio version 0.98.1102 (2009–2014, R Studio, Inc.). Data were non-normal, skewed and zero-inflated. For that reason, non-parametric tests such as Mann-Whitney and Kruskal-Wallis were used. The variables 'Litter Presence' and 'Litter Mass' were tested against relevant variables such as 'Food Presence' and the main food categories using a Mann-Whitney-Wilcoxon Test. A Kruskal-Wallis test was used to investigate if the variables 'Litter Presence' and 'Litter Mass' were influenced by the variable 'Species'.

The present study analysed 80 individual regurgitates from chicks of 3 different species. Samples were collected from 2011 to 2015 at 4 different breeding colonies along the coast of Ireland, described in Table 1. Due to the opportunistic nature of this sampling, sample sizes were limited and spatial and temporal differences were not taken into account in this particular work. Instead, all colonies and years were considered together in order to improve the power of statistical analysis. From all regurgitates analysed (n = 80), 11.3% (n = 9) contained plastic litter (Fig. 1). Regurgitates from all 3 studied species contained plastic litter, from 3 different colonies: Black-legged Kittiwakes (n = 3), Great Cormorants (n = 2) and Northern Fulmars (n = 4). Plastic categories were fragments (44.4%), sheet (33.3%) and foam (22.2%). Two individuals (1 Black-legged Kittiwake and 1 Great Cormorant) contained also non-plastic litter (fragments of paraffin wax).

Plastic litter ingestion was higher in Northern Fulmar chicks, with a 28.6% frequency of occurrence (FO), an average mass of 0.0129 g (Range: 0–0.1043 g. SD ± 0.0317) and an average number of particles of 0.50 (Range: 0–3. SD ± 0.90); followed by Black-legged Kittiwakes

Fig. 1. Sample containing plastic litter (type: sheet) found in regurgitate from a Black-legged Kittiwake chick.
Rockabill, Co. Dublin, 2013.

with 7.9% FO, 0.0001 g average plastic mass (Range: 0–0.0045 g. SD ± 0.0007) and 0.08 average number of particles (Range: 0–1. SD ± 0.26); and lastly, Great Cormorants with 7.1% FO, an average mass of 0.0123 g (Range: 0–0.3450 g. SD ± 0.0640), average number of particles of 0.21 (Range: 0–5. SD ± 0.93) (Table 2).

When testing if species had any effect on the mass of plastic litter, we found no significant differences among all three study species ($p = 0.075$). No significant difference was found when testing if food presence, or any of selected food items had an influence on the presence of plastic litter.

This study aimed to investigate ingestion of plastics by chicks of three species of seabird in Ireland and set baseline data by using an opportunistic sampling method (spontaneous regurgitation). Our results have shown that chicks are ingesting litter, mainly plastics. These birds have not left the nest and yet, have been contaminated by the ingestion of anthropogenic debris fed to them via parents.

Our results show that the frequency of plastic occurrence in chick regurgitates of Northern Fulmars was higher (28.6%) than Black-legged Kittiwakes (7.9%) and Great Cormorants (7.1%). Ingestion of plastics has been connected to foraging strategy by various studies (Azzarello and Van Vleet, 1987; Ryan, 1988a, 1988b; Shephard et al., 2015). Surface seizing birds would be more likely to come across positively buoyant plastics (Moser and Lee, 1992). Birds with a generalist diet are more prone to mistaking plastics for food items (Moser and Lee, 1992). Northern Fulmars are both surface feeders and generalist feeders (Burg et al., 2003; Mallory, 2006), with our results thus reinforcing such connection between plastic ingestion and feeding strategy and diet. Previous authors have reported that young birds have more plastics in their stomachs than adults (Acampora et al., 2014; Carey, 2011). This could be explained by parental delivery when feeding chicks, or perhaps because young birds could be more naïve when feeding by themselves. In the case of the birds in this study, the former would apply as samples were collected from chicks, which were still completely dependent on parents for their food requirements. When comparing prevalence of plastic litter in adult birds from the same region, Acampora et al. (2016) found a higher prevalence (93%) in corpses of Northern Fulmars, with an equal sample size (n = 14) to the chick regurgitates from this study. The same was true for stomach contents of Black-legged Kittiwakes, with a 50% prevalence, but in a smaller sample size (n = 4). Previous work on Great Cormorants in Ireland found a 3.2% plastic prevalence in boluses (Acampora et al., 2017).

When using this type of dietary analysis, comparison between species should be done with caution, taking species' biology regarding

Table 2
Plastic litter abundance per species (ordered by sample size; population averages are provided and included zero values). CI = Confidence interval, SD = standard deviation.

Species	Sample (n)	Frequency of occurrence (%) – 95% CI	Average number of particles (n) ± SD	Average mass (g) ± SD
Black-legged Kittiwake	38	7.9	0.08 ± 0.26	0.0002 ± 0.0007
Great Cormorant	28	7.1	0.21 ± 0.93	0.0123 ± 0.0640
Northern Fulmar	14	28.6	0.50 ± 0.90	0.0129 ± 0.0317

accumulation and regurgitation into consideration (Lindborg et al., 2012). For instance, Procellariiform birds have a restricted regurgitation ability due to the constriction between their proventriculus and their gizzard (Azzarello and Van Vleet, 1987), so even when they regurgitate their stomach contents as a defence mechanism (stomach oil), they would only be able to regurgitate the upper part of the stomach (proventriculus), but not the part that accumulates the hard, indigestible matter (gizzard) (Karnovsky et al., 2012). Therefore, sampling regurgitates from such species only provides a snapshot of what their stomach contents are. This has to be taken into account in both stages: when the parent delivers the food to the chick and when the chick regurgitates as a response to disturbance. Yet in this study, Northern Fulmars had the highest prevalence of plastic ingestion.

Although Black-legged Kittiwakes chicks had a lower rate of plastic litter ingestion in this study, the FO (7.9%) is similar to that reported by Robards et al. (1995) of 7.8% and by Poon et al. (2017) of 9% for adult birds. However, plastic litter has been reportedly used as nesting material for Black-legged Kittiwakes in 57% of nests in Danish colonies (Hartwig et al., 2007), perhaps providing chicks with opportunities for accidental ingestion or entanglement.

For birds that regurgitate indigestible matter daily (Cormorants) or after each meal (Gulls and Skuas) (Barrett et al., 2007), there may be a lower probability of detecting plastics in their stomachs via necropsies of dead birds, as particles could have been previously expelled via a bolus. However, in our study adults have delivered plastics to chicks and, while at low levels, in the case of Great Cormorants (7.1%), chicks' regurgitates also represent a reflection of the parents' diet, even if the plastics quantified in this study only reflect the last ingested meal or meals throughout the day in which the samples were collected (Johnstone et al., 1990). Additionally, it is necessary to take into account that colony sampling means adults could be feeding chicks differently than they would feed themselves outside of the chick rearing period (Bearhop et al., 2001). Nevertheless, chicks are being exposed to plastic litter via regurgitation through their parents, which could affect growth and fledgling survival.

The majority of the Irish populations of Northern Fulmar and Black-legged Kittiwake (30 largest colonies in the country, comprising about 90–95% of the population in year 2000) were resurveyed in the summer of 2015 (Newton et al., 2015, unpublished report to National Parks & Wildlife Service). These showed that Northern Fulmars had declined by 12% and Black-legged Kittiwakes by 33% over a 15 year period. The most likely explanations for this are declining prey fish stocks, perhaps related to climate change, overfishing or diminishing discarding. This study, along with the growing body of literature on plastic pollution, has demonstrated that populations of seabirds are vulnerable to interactions with plastics throughout their life cycle, thus more research into the prevalence and impacts of plastics is needed to investigate as to whether ingested plastics could yet be another factor involved in such demographic decline. A diet containing plastics could prevent seabird chicks from getting adequate body condition prior to fledging, which is essential for fledgling survival (Arizaga et al., 2015; Lavers et al., 2014).

The presence of plastics in chick's diet confirms that plastics are present in many seabird species throughout their life cycle. The use of chick regurgitates has proved to be a valid approach, when consideration is taken related to anatomic differences in species. Our previous work (Acampora et al., 2016) has utilised beached birds as a tool for multispecies monitoring of marine litter. Different approaches of monitoring, rather than a single one, offer more reliable information and, with such compilation of data, it is expected in the future to be able to infer a health status for seabird populations in Ireland.

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References

Acampora, H., Berrow, S., Newton, S., O'Connor, I., 2017. Presence of plastic litter in pellets from Great Cormorant (Phalacrocorax carbo) in Ireland. Mar. Pollut. Bull. 117 (1), 512–514.

Acampora, H., Lyashevska, O., Van Franeker, J.A., O'Connor, I., 2016. The use of beached bird surveys for marine plastic litter monitoring in Ireland. Mar. Environ. Res. 120, e87–e91. http://dx.doi.org/10.1016/j.marenvres.2016.08.002.

Acampora, H., Schuyler, Q.A., Townsend, K.A., Hardesty, B.D., 2014. Comparing plastic ingestion in juvenile and adult stranded short-tailed shearwaters (*Puffinus tenuirostris*) in eastern Australia. Mar. Pollut. Bull. 78, 63–68.

Arizaga, J., Herrero, A., Aldalur, A., Cuadrado, J.F., Oro, D., 2015. Effect of pre-fledging body condition on juvenile survival in Yellow-legged Gull *Larus michahellis*. Acta Ornithol. 50, 1–9. http://dx.doi.org/10.3161/00016454AO2015.50.2.002.

Avery-Gomm, S., Provencher, J.F., Morgan, K.H., Bertram, D.F., 2013. Plastic ingestion in marine-associated bird species from the eastern North Pacific. Mar. Pollut. Bull. 72, 257–259. http://dx.doi.org/10.1016/j.marpolbul.2013.04.021.

Azzarello, M., Van Vleet, E., 1987. Marine birds and plastic pollution. Mar. Ecol. Prog. Ser. 37, 295–303. http://dx.doi.org/10.3354/meps037295.

Barrett, R.T., Camphuysen, K., Anker-Nilssen, T., Chardine, J.W., Furness, R.W., Garthe, S., Hüppop, O., Leopold, M.F., Montevecchi, W.a., Veit, R.R., 2007. Diet studies of seabirds: a review and recommendations. ICES J. Mar. Sci. 64, 1675–1691. http://dx.doi.org/10.1093/icesjms/fsm152.

Bearhop, S., Thompson, D.R., Phillips, R.A., Waldron, S., Hamer, K.C., Gray, C.M., Votier, S.C., Ross, B.P., Furness, R.W., 2001. Annual variation in great skua diets: the importance of commercial fisheries and predation on seabirds revealed by combining dietary analyses. Condor 103, 802–809. http://dx.doi.org/10.1650/0010-5422(2001)103[0802:avigsd]2.0.co;2.

Bergmann, M., Gutow, L., Klages, M., 2015. Marine anthropogenic litter. In: Marine Anthropogenic Litter, http://dx.doi.org/10.1007/978-3-319-16510-3.

Bond, A.L., Jones, I.L., Williams, J.C., Byrd, G.V., 2010. Auklet (Charadriiformes: Alcidae, *Aethia* spp.) chick meals from the Aleutian Islands, Alaska, have a very low incidence of plastic marine debris. Mar. Pollut. Bull. 60, 1346–1349. http://dx.doi.org/10.1016/j.marpolbul.2010.05.001.

Bond, A.L., Lavers, J.L., 2013. Effectiveness of emetics to study plastic ingestion by Leach's Storm-petrels (*Oceanodroma leucorhoa*). Mar. Pollut. Bull. 70. http://dx.doi.org/10.1016/j.marpolbul.2013.02.030.

Bond, A.L., Montevecchi, W.A., Guse, N., Regular, P.M., Garthe, S., Rail, J.F., 2012. Prevalence and composition of fishing gear debris in the nests of northern gannets (*Morus bassanus*) are related to fishing effort. Mar. Pollut. Bull. 64, 907–911. http://dx.doi.org/10.1016/j.marpolbul.2012.03.011.

Burg, T.M., Lomax, J., Almond, R., Brooke, M.D.L., Amos, W., 2003. Unravelling dispersal patterns in an expanding population of a highly mobile seabird, the Northern Fulmar (*Fulmarus glacialis*). Proc. Biol. Sci. 270, 979–984. http://dx.doi.org/10.1098/rspb.2002.2322.

Carey, M.J., 2011. Intergenerational transfer of plastic debris by Short-tailed Shearwaters (*Ardenna tenuirostris*). Emu 111, 229–234. http://dx.doi.org/10.1071/MU10085.

Cousin, H.R., Auman, H.J., Alderman, R., Virtue, P., 2015. The frequency of ingested plastic debris and its effects on body condition of short-tailed shearwater (*Puffinus tenuirostris*) pre-fl edging chicks in Tasmania, Australia. Emu 115, 6–11.

Derraik, J.G.B., 2002. The pollution of the marine environment by plastic debris: a review. Mar. Pollut. Bull. 44, 842–852. http://dx.doi.org/10.1016/S0025-326X(02)00220-5.

Gall, S.C., Thompson, R.C., 2015. The impact of debris on marine life. Mar. Pollut. Bull. http://dx.doi.org/10.1016/j.marpolbul.2014.12.041.

Hammer, S., Nager, R.G., Johnson, P.C.D., Furness, R.W., Provencher, J.F., 2016. Plastic debris in great skua (*Stercorarius skua*) pellets corresponds to seabird prey species. Mar. Pollut. Bull. http://dx.doi.org/10.1016/j.marpolbul.2015.12.018.

Hartwig, E., Clemens, T., Heckroth, M., 2007. Plastic Debris as Nesting Material in a Kittiwake - (*Rissa tridactyla*) - Colony at the Jammerbugt, Northwest Denmark. 54. pp. 595–597. http://dx.doi.org/10.1016/j.marpolbul.2007.01.027.

Johnstone, I.G., Harris, M.P., Wanless, S., Graves, J.a., 1990. The usefulness of pellets for assessing the diet of adult shags *Phalacrocorax aristotelis*. Bird Study 37, 37–41. http://dx.doi.org/10.1080/00063659009477030.

Karnovsky, N.J., Hobson, K.A., Iverson, S.J., 2012. From lavage to lipids: estimating diets of seabirds. Mar. Ecol. Prog. Ser. 451, 263–284. http://dx.doi.org/10.3354/meps09713.

Koelmans, A.A., 2015. In: Bergmann, M., Gutow, L., Klages, M. (Eds.), Marine Anthropogenic Litter. Springer International Publishing, Cham, pp. 309–324. http://dx.doi.org/10.1007/978-3-319-16510-3_11.

Kühn, S., Bravo Rebolledo, E.L., Franeker, J.A., 2015. In: Bergmann, M., Gutow, L., Klages, M. (Eds.), Marine Anthropogenic Litter. Springer International Publishing, Cham, pp. 75–116. http://dx.doi.org/10.1007/978-3-319-16510-3_4.

Laist, D., 1997. Marine Debris, Society, Springer Series on Environmental Management. Springer New York, New York, NY. http://dx.doi.org/10.1007/978-1-4613-8486-1.

Lavers, J.L., Bond, A.L., Hutton, I., 2014. Plastic ingestion by flesh-footed shearwaters (*Puffinus carneipes*): implications for fledgling body condition and the accumulation of plastic-derived chemicals. Environ. Pollut. 187, 124–129. http://dx.doi.org/10.1016/j.envpol.2013.12.020.

Lavers, J.L., Hodgson, J.C., Clarke, R.H., 2013. Prevalence and composition of marine debris in Brown Booby (*Sula leucogaster*) nests at Ashmore Reef. Mar. Pollut. Bull. 77, 320–324. http://dx.doi.org/10.1016/j.marpolbul.2013.09.026.

Lindborg, V.a., Ledbetter, J.F., Walat, J.M., Moffett, C., 2012. Plastic consumption and diet of Glaucous-winged Gulls (*Larus glaucescens*). Mar. Pollut. Bull. 64, 2351–2356. http://dx.doi.org/10.1016/j.marpolbul.2012.08.020.

Mallory, M.L., 2006. The Northern Fulmar (*Fulmarus glacialis*) in Arctic Canada: ecology, threats, and what it tells us about marine environmental conditions. Environ. Rev. 14, 187–216. http://dx.doi.org/10.1139/a06-003.

Moser, M., Lee, D., 1992. A 14-year survey of plastic ingestion by western North-Atlantic seabirds. Colon. Waterbirds 15, 83–94. http://dx.doi.org/10.2307/1521357.

Poon, F.E., Provencher, J.F., Mallory, M.L., Braune, B.M., Smith, P.A., 2017. Levels of ingested debris vary across species in Canadian Arctic seabirds. Anal. Methods 9, 1454–1469. http://dx.doi.org/10.1039/C6AY02419J. (Paper).

Provencher, J., Bond, A., Aver-Gomm, S., Borrelle, S., Bravo Rebolledo, E., Hammer, S., Kuhn, S., Lavers, J., Mallory, M., Trevail, A., van Franeker, J., 2016. Quantifying ingested debris in marine megafauna: a review and recommendations for standardization. Anal. Methods. http://dx.doi.org/10.1039/C6AY02419J.

Provencher, J.F., Bond, A.L., Mallory, M.L., 2014. Marine birds and plastic debris in Canada: a national synthesis, and a way forward. Environ. Rev. 1–13. http://dx.doi.org/10.1139/er-2014-0039. (in press).

Robards, M.D., Piatt, J.F., Wohl, K.D., 1995. Increasing frequency of plastic ingested by seabirds in the subarctic North Pacific. Mar. Pollut. Bull. 30, 151–157 (doi:0025-326X(94)00121-9).

Rodríguez, A., Rodríguez, B., Nazaret Carrasco, M., 2012. High prevalence of parental delivery of plastic debris in Cory's shearwaters (*Calonectris diomedea*). Mar. Pollut. Bull. 64. http://dx.doi.org/10.1016/j.marpolbul.2012.06.011.

Roman, L., Schuyler, Q.A., Hardesty, B.D., Townsend, K.A., 2016. Anthropogenic Debris Ingestion by Avifauna in Eastern Australia. pp. 1–14. http://dx.doi.org/10.5061/dryad.p48f7.

Ryan, P.G., 1988a. Effects of ingested plastic on seabird feeding: evidence from chickens. Mar. Pollut. Bull. 19, 125–128.

Ryan, P.G., 1988b. Intraspecific variation in plastic ingestion by seabirds and the flux of plastic through seabird populations. Condor 90, 446–452.

Shephard, S., van Hal, R., de Boois, I., Birchenough, S.N.R., Foden, J., O'Connor, J., Geelhoed, S.C.V., Van Hoey, G., Marco-Rius, F., Reid, D.G., Schaber, M., 2015. Making progress towards integration of existing sampling activities to establish Joint Monitoring Programmes in support of the MSFD. Mar. Policy 59, 105–111. http://dx.doi.org/10.1016/j.marpol.2015.06.004.

Sievert, P.R., Sileo, L., 1993. The effects of ingested plastic on growth and survival of albatross chicks. In: Status, Ecol. Conserv. Mar. Birds North Pacific, pp. 212–217.

Sileo, L., Sievert, P.R., Samuel, M.D., 1990. Causes of mortality of albatross chicks at Midway Atoll. J. Wildl. Dis. 26, 329–338. http://dx.doi.org/10.7589/0090-3558-26.3.329.

Tanaka, K., Takada, H., Yamashita, R., Mizukawa, K., Fukuwaka, M., Watanuki, Y., 2015. Facilitated leaching of additive-derived PBDEs from plastic by seabirds' stomach oil and accumulation in tissues. Environ. Sci. Technol. 150901174241000. http://dx.doi.org/10.1021/acs.est.5b01376.

Van Franeker, J.A., Law, K.L., 2015. Seabirds, gyres and global trends in plastic pollution. Environ. Pollut. 203, 89–96. http://dx.doi.org/10.1016/j.envpol.2015.02.034.

Van Franeker, J.A., Meijboom, A., de Jong, M.L., 2003. Marine Litter Monitoring by Northern Fulmars in the Netherlands 1982–2003. Wageningen, Alterra, Alterra-rapport. 1093.

Young, L.C., Vanderlip, C., Duffy, D.C., Afanasyev, V., Shaffer, S.a., 2009. Bringing home the trash: do colony-based differences in foraging distribution lead to increased plastic ingestion in Laysan albatrosses? PLoS One 4, 11–13. http://dx.doi.org/10.1371/journal.pone.0007623.