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Impacts of anthropogenic waste on Tasmanian Pacific Gull (Larus pacificus) diet

Anne Bartlett
SIT Study Abroad

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Abstract

Plastic pollution is one of the foremost environmental issues that the world is currently experiencing. The effects of plastic pollution are great and range from leaching of hazardous chemicals into the environment to ingestion of plastic waste by wildlife, including seabirds. Due to the high rates of plastic consumption by seabirds, many recent studies have been performed to determine the biological impacts of plastic consumption on various seabird species. The Pacific Gull (*Larus pacificus*) is the world's largest sea gull and the only gull endemic to Australia, yet very limited information exists on this species. This study examines the impacts of anthropogenic debris, including plastic waste, on the diet of Pacific Gulls in Launceston, Tasmania and attempts to determine if there is any seasonal variation in diet or ingestion of debris. Plastic was found in 86.92% of processed boluses, and anthropogenic debris made up 39.85% of the average mass of all the processed boluses. No seasonal variation in diet was found. Further research needs to be conducted to better understand the impacts of anthropogenic waste on this species specifically.

Keywords: seabirds, debris, pollution, plastic pollution, tip site, ingestion, bolus, regurgitation, breeding

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Introduction

Due to the increased use of plastic over the past several decades since its invention, plastic debris can now be found in all regions of the globe, from densely populated coastal areas to the most remote areas of the world, including Antarctica (Hammer, Nager, Johnson, Furness, & Provencher, 2016; Provencher et al., 2017). In fact, plastic pollution is now considered among the most significant environmental issues the world faces today (Hammer et al., 2016; Provencher et al., 2017; Seif et al., 2018). Plastic debris is added to the environment at much higher rates than those at which it is removed, and the amount of marine plastic pollution is predicted to continue increasing with increased consumption (Lindborg, Ledbetter, Walat, & Moffett, 2012). The abundance of plastic in global ecosystems presents a serious issue because the extremely slow rate of plastic decomposition allows it to remain in the environment for extremely long periods of time, which prolongs the amount of time the plastic waste can impact the environment (Seif et al., 2018).

In addition to various environmental impacts such as chemical leaching, plastic pollution can negatively impact wildlife either through entanglement or ingestion. Ingestion of plastic debris can either damage the digestive tract or cause blockage in the stomachs of organisms that ingest it (Acampora, Berrow, Newton, & O'Connor, 2017; Lindborg et al., 2012; Provencher et al., 2017; Seif et al., 2018). First reports of plastic debris found to be ingested by marine megafauna occurred in the 1960s and such reports greatly increased in the 1970s (Provencher et al., 2017).

Due to their relatively high abundance and accessibility, seabirds are often used as study subjects and act as indicators of environmental quality (Acampora et al., 2017; Hammer et al., 2016; Provencher et al., 2017; Seif et al., 2018). Some seabirds are able to regurgitate pellets (boluses) of indigestible material that has been consumed. These boluses are a often used when studying the diets of birds because collecting and processing them is non-invasive and not harmful to the birds or the environment in any way as compared to collecting live samples to perform necropsies on stomach contents (Acampora et al., 2017; Lenzi, Burgues, Carrizo, Machín, & Teixeira-de Mello, 2016; Lindborg et al., 2012).

Many studies in recent years have been conducted to determine the impact of plastic pollution on seabirds. A study of Glacous-winged Gulls in the Salish Sea, Canada in the 1970s showed zero plastic debris in any of the boluses, with only 0.3% of the processed boluses containing any anthropogenic debris at all (Lindborg et al., 2012). A study of the same species in 2012 showed that 12% of the boluses collected and processed contained plastic (Lindborg et al., 2012). In just a matter of decades, the amount of debris, including plastics, that is ingested by seabirds has increased greatly. In Herring Gulls, Great Black-backed Gulls, and Iceland Gulls that were studied in Newfoundland, Canada, total accumulated debris was found in 77%, 75%, and 100% of individuals, respectively, and plastic debris specifically was found in 61%, 61%, and 100% of individuals, respectively (Seif et al., 2018). The amount of plastic pollution present throughout the world has a strong impact on the diet of many different seabird species.

Despite all this research, there have been few recent published studies on the Pacific Gull (*Larus pacificus*), the only gull endemic to Australia. This study examines the boluses of Tasmanian

Pacific Gulls to determine an overview of what these animals are eating, both natural and anthropogenic. This study also analyzes whether or not there is a seasonal variation in the diet of these birds. It is predicted that there will be a high prevalence of anthropogenic debris in these boluses due to the tendency of these birds to feed at tip sites. Because these birds live in an area with a high human population, no seasonal variation in diet is expected due to the constant presence of anthropogenic waste as a source of food for these birds.

Methods

Study Species

Pacific Gulls (*Larus pacificus*) are "omnivorous predators, scavengers, and kleptoparasites… [they] take almost anything available of suitable size and texture, including offal and human waste" (Griffin, 2013). Populations of Pacific Gulls are often associated with human populations because the gull populations increase with the increase in availability of food, such as anthropogenic debris. Anthropogenic debris is found more abundantly in areas with higher human population density (Griffin, 2013). Pacific Gulls of northern Tasmania have been witnessed feeding at local tip sites (Figure 1).


Figure 1. Gulls feeding at the local tip site. Photo courtesy of Dr. Jennifer Lavers.

Little is known about Pacific Gull breeding habits because few major studies have been published on this species, but the breeding season in general is estimated to occur between September and January, conservatively (Griffin, 2013). The Pacific Gull was chosen as the study species for this project because of their relatively high abundance, ease of studying, and because of the lack of information that exists about them despite their abundance.

Bolus Collection

A population of Tasmanian Pacific Gulls roost at night and deposit boluses along the boardwalks of the Tamar Wetlands located north of Launceston, Tasmania (41°23'36" S, 147°04'21" E) (Figure 2). The boluses used for this study were collected on a monthly basis beginning from

May 2018 through April 2019 from these boardwalks. Only complete, intact boluses were collected in order to ensure that the entire bolus is included rather than just a portion. Collected boluses were put into bags and stored in a freezer at -25°C at University of Tasmania, Newnham campus until they were ready to be processed.

Figure 2. Pacific Gulls roosting along the boardwalks of the Tamar Wetlands at dusk. Photo courtesy of My Wild Australia.

Bolus Processing

Ten gull boluses from each month were processed and used for ingestion data, with the exception of August 2018 (n=4) and October 2018 (n=3) due to previous errors in data transcription that could not be sorted out during the time frame of this study. A total of 107 processed boluses were included in this dataset. Boluses were processed by removing them from the freezer and letting them thaw overnight before dissection. Once thawed, boluses were pulled apart and contents were sorted into the natural and anthropogenic materials following standards developed by Lindborg et al (2012). Natural materials included vegetation, rocks, pumice, mollusks, arthropods, feathers, fish bones, and other bones. Anthropogenic materials included processed wood/paper, chicken bones, egg shells, metal, glass, and plastic.

Plastics were categorized both by color (white, orange/brown, blue/purple, green, red/pink, yellow, and black) and by type (nurdle, foam, thread, sheet, fragment, and other) according to the standards set forth by Provencher et al (2017) based off of classification methods used by the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) Ecological Quality Objectives (EcoQO). Once sorted, the number of each type of material was counted and weighed to the nearest .001 gram. The data was then entered into a master spreadsheet for analysis.

Data Analysis

Data was analyzed using Excel to graph numerous different variables in order to create an overview of the gulls' diets as well as to examine whether or not there is any seasonal variation in diet or amount of anthropogenic debris that is ingested. The average mass of the boluses as well as the average mass of each category was calculated along with the frequency of occurrence of all categories and the percent composition by mass of natural versus anthropogenic items for all boluses regardless of season. For the seasonal data, boluses were divided up by the month they were collected, and the average monthly bolus mass, average monthly plastic mass, and the percent composition by mass of natural versus anthropogenic items on a monthly basis were all calculated. Where applicable, standard error was calculated in order to compare the differences between the various variables.

Results

Overview of diet

A total of 107 processed boluses were included in this data analysis. Items from all categories, both natural and anthropogenic, were present across the sample of boluses. A total of 1,067 individual pieces of plastic were found among the 107 boluses. Anthropogenic debris items included polystyrene foam balls, plastic sheet bags, plastic wrappers, string, bottle caps, foil wrappers, and fragments of glass, among many others. Anthropogenic items were found in 96.26% of processed boluses (n=103).

Vegetation had the highest average mass (0.74 grams, standard error ± 0.08 grams), followed by chicken bone (0.37 grams, standard error ± 0.10 grams), rock (0.23 grams, standard error ± 0.04 grams), and glass (0.16 grams, standard error ± 0.03 grams) (Figure 3). Mass is not a sufficient comparison of abundance of each category, however, because different materials have different average weights. The frequency of occurrence shows how much a specific category was present in each bolus. Vegetation (n=98; 91.59%), plastic (n=93; 86.92%), rock (n=79; 73.83%), and glass (n=67; 62.62%) were found most frequently and were the only items to be found in more than half the processed boluses (Table 1). When the individual categories were combined into natural items (vegetation, other bones, fish bone, feather, mollusc, arthropod, rock, and pumice) and anthropogenic items (processed wood/paper, chicken bone, egg shell, glass, metal, and plastic), anthropogenic items made up 39.85% of total bolus mass while natural items made up 60.15% (Figure 4).

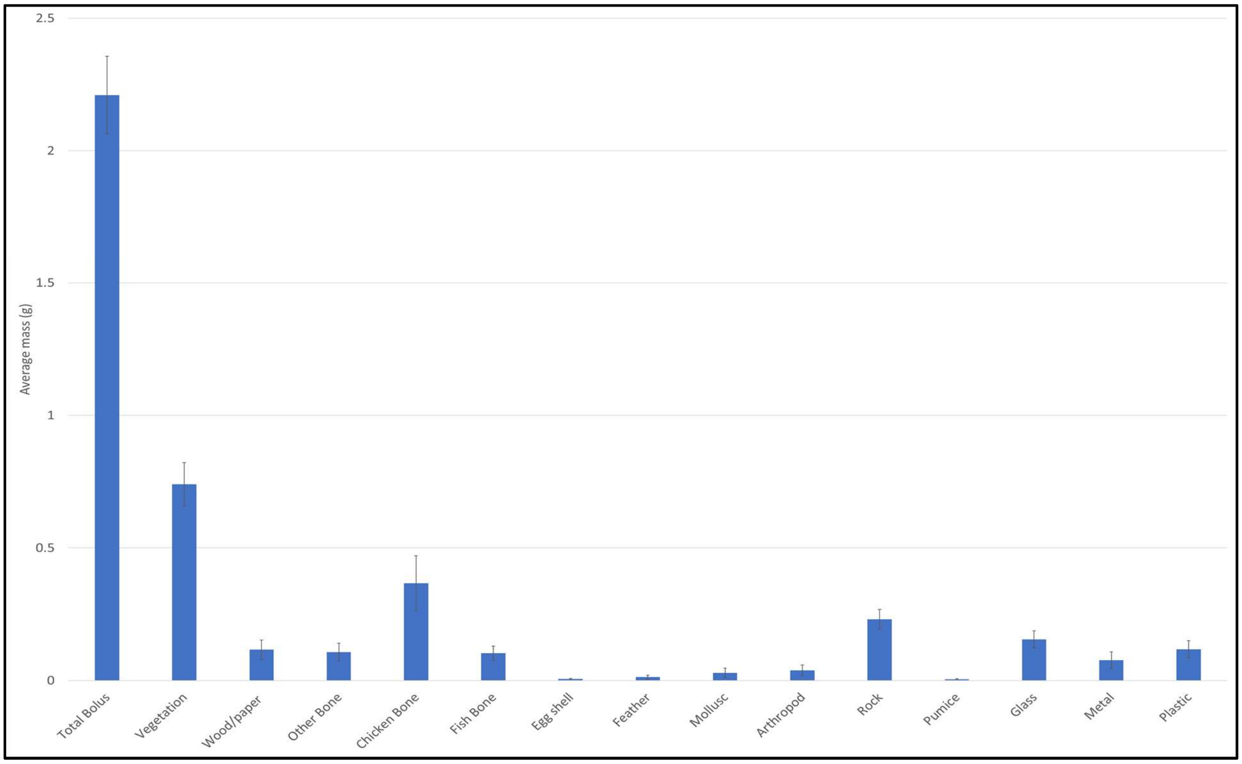

Figure 3. Average mass of each category for all boluses. Error bars represent standard error (n=107).

Table 1. The number of processed boluses that contained each category and the overall frequency of occurrence of each category as a percentage of total processed boluses.

Item	Count	Frequency of Occurrence (%)	Item	Count	Frequency of Occurrence (%)
Vegetation	98	91.59	Rock	79	73.83
Wood/Paper	40	37.38	Pumice	2	1.87
Other Bone	29	27.10	Glass	67	62.62
Chicken Bone	35	32.71	Metal	21	19.63
Fish Bone	23	21.50	Plastic	93	86.92
Egg Shell	26	24.30			
Feather	52	48.60			
Mollusc	23	21.50			
Arthropod	9	8.41	Total # of Processed Boluses	**107**	

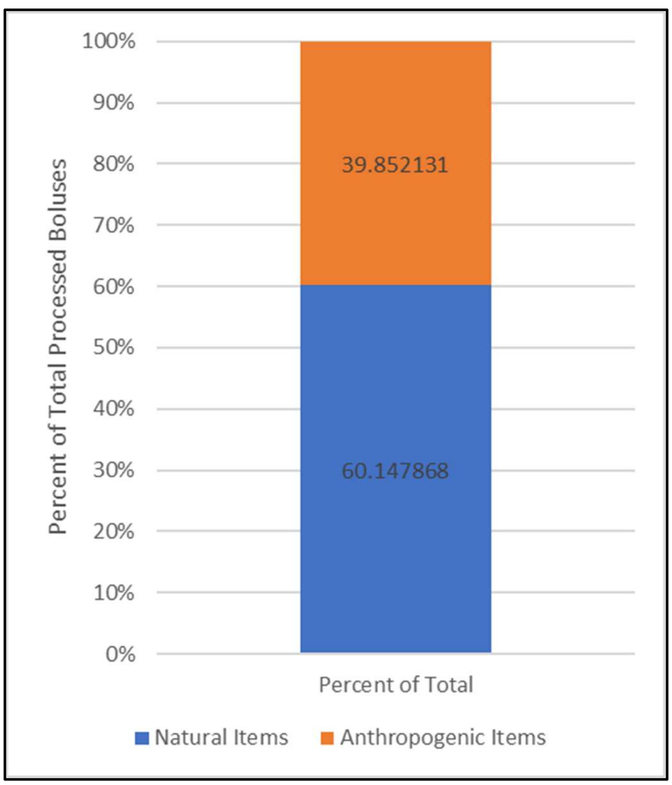

Figure 4. Percent composition by mass of all the processed boluses separated by natural versus anthropogenic items. Natural items included vegetation, other bones, fish bones, feathers, molluscs, arthropods, rocks, and pumice. Anthropogenic items included chicken bones, egg shells, processed wood/paper, glass, metal, and plastics.

Seasonal Diet

July 2018 had the highest average mass (3.33 grams, standard error ± 1.79 grams) while November 2018 had the lowest average mass (1.29 grams, standard error ± 0.69 grams) (Figure 5). However, average bolus mass showed no signs of seasonal variation. When taking the standard error into consideration for each average monthly mass, there was overlap for nearly all months (Figure 5).

When considering just the mass of the plastic ingested on a monthly basis, June 2018 had the highest average mass (0.41 grams, standard error ± 0.30 grams) while December 2018 had the lowest average mass (0.02 grams, standard error ± 0.01 grams) (Figure 6). Once again, average plastic mass showed no signs of seasonal variation; there was overlap between standard error for all months (Figure 6).

When the individual categories were divided into natural and anthropogenic items on a monthly basis, percent composition by mass of each category did not show a seasonal trend either. June 2018 had the highest percentage by mass of anthropogenic debris (52.72% anthropogenic, 47.28% natural) while April 2019 had the lowest percentage by mass of anthropogenic debris (21.73% anthropogenic, 78.27% natural) (Figure 7).

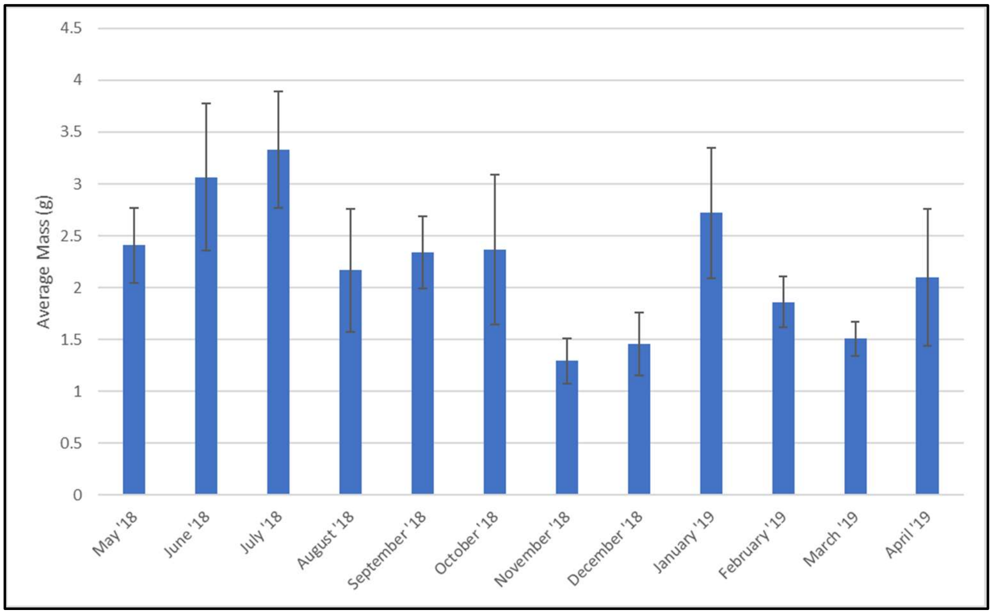

Figure 5. Average bolus mass on a monthly basis. Error bars represent standard error (n=10 for all months except August ’18 (n=4) and October ’18 (n=3)).

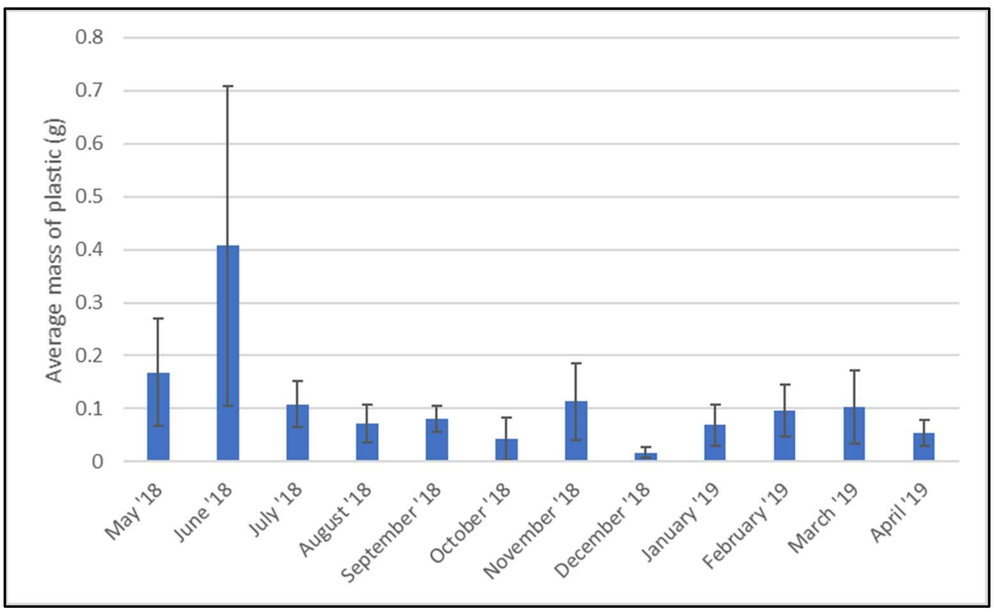

Figure 6. Average mass of total plastic found in processed boluses on a monthly basis. Error bars represent standard error (n=10 for all months except August ’18 (n=4) and October ’18 (n=3)).

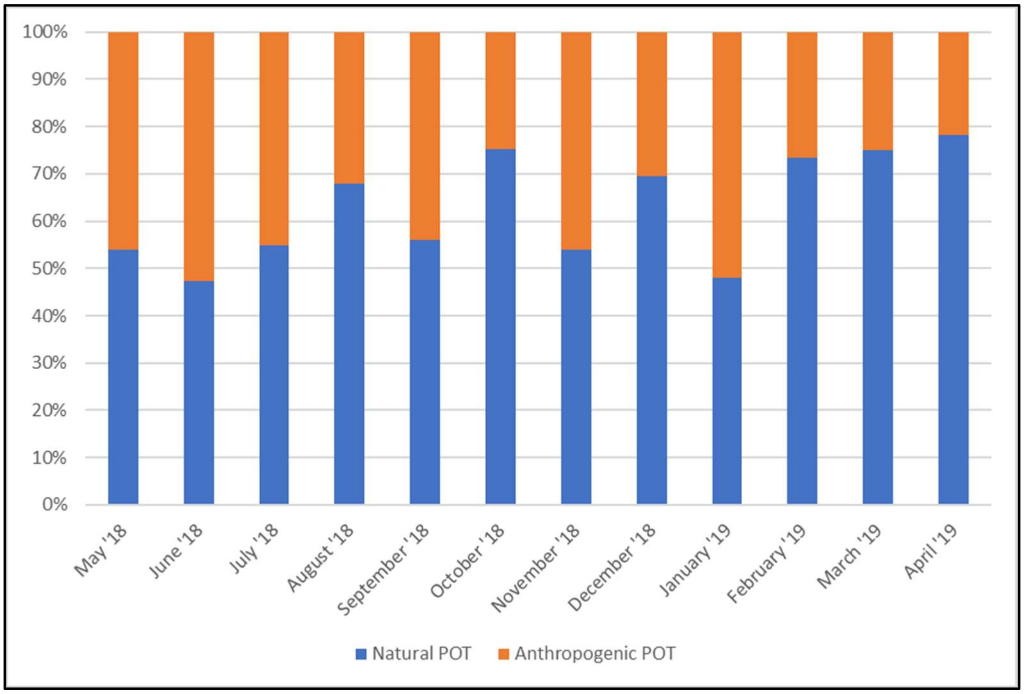

Figure 7. Percent composition by mass of all the processed boluses separated by item category on a monthly basis. POT = Percent of Total. Natural items included vegetation, other bones, fish bones, feathers, molluscs, arthropods, rocks, and pumice. Anthropogenic items included chicken bones, egg shells, processed wood/paper, glass, metal, and plastics.

Discussion

Anthropogenic items were found in 96.26% of processed boluses, and plastic specifically was found in 86.92% of the boluses. Gulls should ideally be feeding on fish, crabs, molluscs, and other natural prey items. This study showed that their diet consists highly of anthropogenic waste products. The high prevalence of inorganic items in the boluses indicates how heavily these seabirds are impacted by anthropogenic waste.

A study performed in 1993 showed that Pacific Gull boluses collected in Hobart, Tasmania primarily consisted of crabs, fish, and chitons, while anthropogenic debris was found in less than 10% of the processed pellets (Coulson & Coulson, 1993). Compared to the 86.92% of processed boluses that contained plastic particles in this study, it shows how drastically the amount of ingested plastic debris has increased over the last 25 years in Tasmania alone. In a 2014 study, however, only 1% of Pacific Gull boluses that were collected from Seal Island in the Bass Strait contained anthropogenic items, including plastic and metal (Leitch, Dann, & Arnould, 2014).

While Hobart is a medium-sized city, Seal Island is a small, uninhabited island consisting of granite rocks off the coast of Victoria. This suggests that the rate of anthropogenic debris ingestion is dependent on gull population location. The high frequency of plastic debris as well as other anthropogenic waste items, such as food product wrappers and chicken bones, in this study of Pacific Gulls in Launceston, Tasmania suggests that these birds are feeding at local tip sites. Because of their opportunistic diet, gulls are especially susceptible to ingestion of waste, especially when they are feeding and residing at or near local tip sites (Seif et al., 2018). This occurs more frequently when gulls reside in areas with high human population, as in Launceston.

Based off the processed boluses that were included in this study, there is not enough evidence to confidently suggest that there is seasonal variation in diet. However, the highest average bolus masses occurred in June and July which are peak winter months while lowest average bolus mass occurred in December which is the peak summer month. This could be due to the higher amount of precipitation that is typically received during winter months in Tasmania which would add water weight to the bolus masses if they were collected while still moist. Regardless, this does not actually suggest a change in diet specifically. This was a relatively small sample size, however, and there are many other variables that could be considered, so future studies may indicate different findings. Due to the lack of published studies on this species, there were no prior results to compare the seasonal data to in order to see if this study was consistent with previous studies.

While relatively little is known about the life history of Pacific Gulls, their proposed breeding season lasts from September to January (Griffin, 2013). The results of this study showed no sign of a change in the diet of gulls during the suggested breeding season. This study could be continued from an alternative perspective to determine if the ingestion of plastic and other anthropogenic debris affects the breeding rates of Pacific Gulls, but that would require a much more intensive study than was possible with this project.

One limitation of this study was the relatively small sample size. There was a high amount of variation in the results, so including more total boluses both overall and on a monthly basis could show different results. Additionally, although bolus processing is a non-invasive, manageable way to study gull diet, it imposes certain limitations on the study. For example, it is impossible to know which individual birds the boluses came from, meaning nothing is known about the health or breeding ability of the individual birds that produce boluses full of debris or if some individuals ingest more anthropogenic debris than others.

Conclusion

In the time since it has been invented, the use of plastic has proliferated to become a staple of everyday life for many people. An overall trend of high consumption is prevalent in many societies, which has led to a dramatic increase in the amount of anthropogenic waste present in the environment. Whether 'contained' in garbage dumps or tip sites or simply dumped in the open environment, this waste has detrimental impacts on the environment and many forms of wildlife. The problem with plastics and many other human-made products is that they take an extremely long time to decompose which means that their environmental effects can last for hundreds of years. In order to reduce these impacts, drastic measures need to be taken to reduce the amount of plastics that are produced and consumed on a daily basis, specifically single-use plastics that are used for much shorter periods of time than they are left in the environment for. A transition to an overall trend of less consumption and an increase in the consumption of organic products to replace inorganic single-use products is vital for the longevity of many organisms and ecosystems.

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