Domestic Cats on Pitcairn Island

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Date of this report: 1 March 2019

Abstract

This document presents the results of a study of *Felis catus*, the domestic cat, on Pitcairn Island. The paper contains three major parts:

- A comprehensive review of the history of domestic cats on Pitcairn, starting with the introduction of cats to Tahiti in 1767
- Results from a field study carried out by the authors in May-June, 2018, using a trail camera, personal observations, and interviews with Pitcairners
- Analysis of the dynamics of human-cat-rat interactions, with the goal of better understanding and managing the future of cats on the island

Major conclusions that emerged from this study include:

- Cats most likely were introduced to Pitcairn by the *Bounty* mutineers in 1790 and probably have been present continuously since then.
- In 2018 there were approximately 67 cats, including 25 pets and 42 feral cats. There are roughly 2 pet cats for every 3 Pitcairn Islanders, and about half of the population lives in a home with at least one pet cat.
- There were at least two instances (ca. 1820 and in 1997) of nearly complete cat eradication. The cat population recovered naturally after 1820, but recovery from the 1997 event required importation of cats.
- The Pitcairn community is not likely to be amenable to another rat and feral cat eradication unless island residents are primary managers and implementers of the project, rats are eradicated before targeting feral cats, and protection of pet cats is assured.

Contents

A kitten (probably feral) on Pitcairn Island, captured by the trail camera on May 31, 2018. Based on the letters on her forehead, we gave her the name “Mew.” Another picture of this kitten is included in this report. (**Appendix 1, Plate 16(c)**).

Introduction

Felis catus, the domestic cat, arrived on Pacific islands along with the early European explorers and traders. They were often taken on voyages for rat control and perhaps also for companionship. Captain Cook left cats on several of the Society Islands, including Tahiti, and cats reached Saipan when a Spanish ship was wrecked there (Duffy et al., 2012). The Samoans had a "passion for cats" and adopted as many cats as they could obtain from whaling ships, but the cats fell out of favor when they began to eat pet birds. Eventually "the cats … multiplied" and became "wild," and moved into the mountains to prey on Samoa's endemic pigeon, *Didunculus strigirostris,* (the tooth-billed pigeon) (Peale, 1848, p. 211).

Because of their sociability, adaptability, and resourcefulness, cats have multiplied and spread worldwide in large numbers. On many islands, introduced cats are now regarded as invasive and are known to present a threat to certain endemic species; they are known to have led to numerous species extinctions in the Pacific islands and elsewhere. Cats have been eradicated from about 100 islands worldwide. However, because of their close association with humans, there is often serious controversy about cat eradication projects, especially on populated islands (Duffy et al., 2012). This paper is about the cats on Pitcairn Island, which have been present in this isolated community over most, if not all, of its 230-year history.

Pitcairn Island

Pitcairn Island, located approximately 320 miles ESE of the Gambier Islands of French Polynesia, is one of the world's most remote inhabited islands. Possibly only Tristan da Cunha[1] is a more isolated community (neither has an airport). The Pitcairn community derives from of one of the most famous events of maritime history, the HMAV[2] *Bounty* mutiny of April 28, 1789. After taking command of the *Bounty* and setting Captain Bligh and most of his loyal crew members adrift in an open launch, the leader of the mutineers, Fletcher Christian, chose Pitcairn Island as a hideout from the British authorities. In January 1790 nine British crew members, six Tahitian men, twelve Tahitian women, and one baby girl landed on the island, and a few days later burned the *Bounty*. Pitcairn, a tiny mountainous island of approximately 6 km^2, had upon its discovery in 1767 been shown incorrectly on charts, and thus seemed to be an ideal hideout. During the first five years of habitation, six of the mutineers and all of the Tahitian men were victims of murder or suicide. When the mutineer hideout was discovered by the American vessel *Topaz* in 1808, the island was populated by one remaining mutineer, John Adams, plus a group of women and children (Kirk, 2008). As of May 2018, Pitcairn Island had a population of 42 people plus roughly eight contract employees on temporary assignment.

[1] *Felis catus* was eradicated from Tristan da Cunha in 1974 (Campbell et al., 2011).
[2] His Majesty's Armed Vessel

Historical record of cats on Pitcairn Island

Figure 1 shows a timeline of Pitcairn Island, from 1750 to the present. Most of the events on this chart are elaborated in the following text.

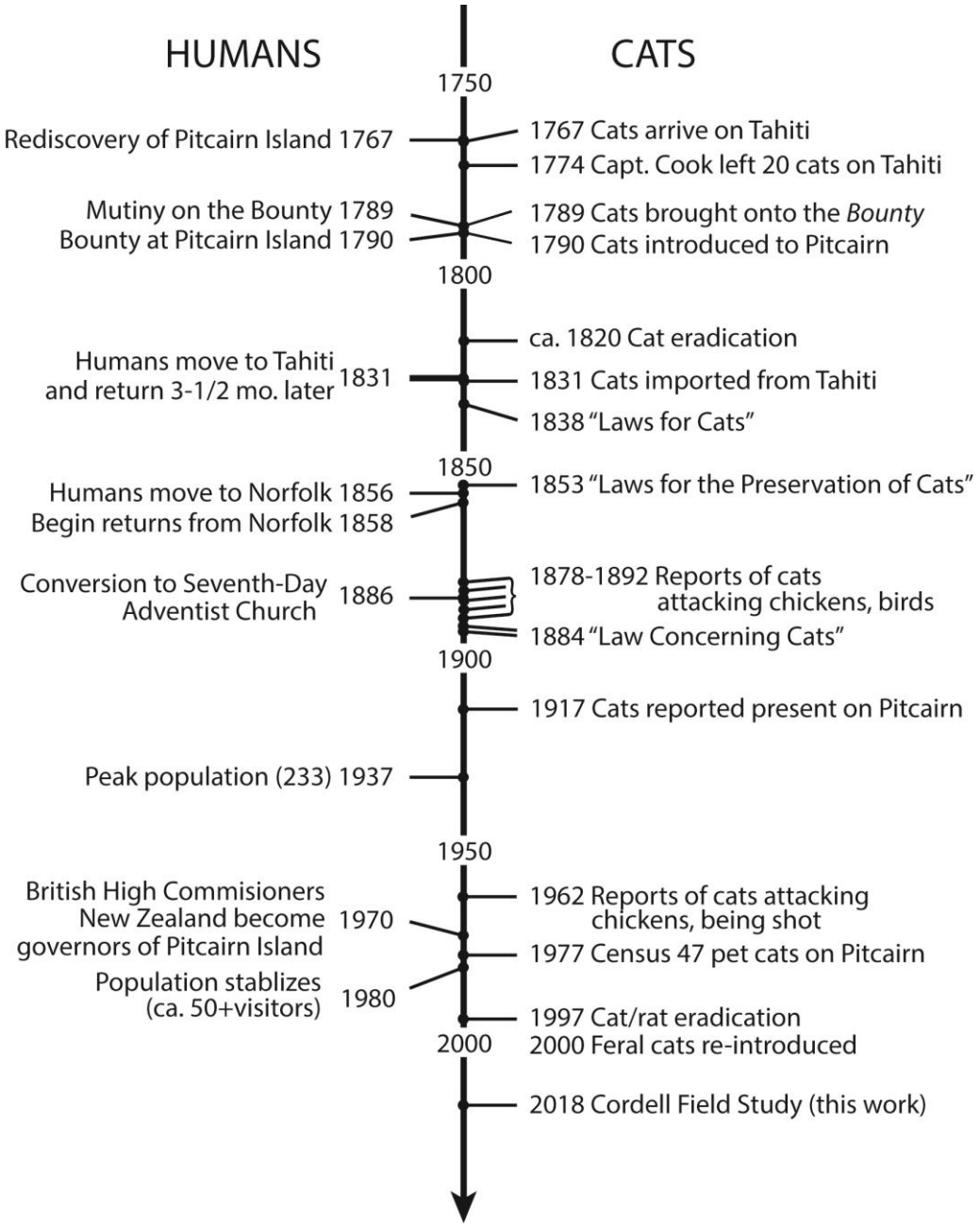


Figure 1 – Timeline of human and cat events on Pitcairn Island.

18th Century: Introduction of cats to the island

Cats first arrived in Tahiti in 1767 with Captain Samuel Wallis on the *Dolphin*.[3] In *Log of Captain Samuel Wallis on the Dolphin During his Voyage Round the World, 1766-1768* (as cited in Alexander, 2003, p. 423), Wallis wrote, "I gave them a Cat big with Kittens of which they were very fond – and Surprized to see her attack the Rats so Eagerly." In 1774 James Cook left 20 cats on Tahiti and additional cats on nearby islands (Duffy et al., 2012). Lt. William Bligh wrote about a Nov. 25, 1788, visit to the *Bounty* by Oberea, a Tahitian friend of Joseph Banks, who brought aboard "a favorite cat that she had bred from one that was given to her by Captn. Cook" (*Official Log of William Bligh*, as cited in Alexander, 2003, p. 423).

On Jan. 31, 1789, Bligh wrote: "When I was at Otaheite with Captain Cook, there were great numbers of rats about all the houses, and so tame that they flocked round the people at their meals for the offals, which were commonly thrown to them; but at this time we scarce ever saw a rat, which must be attributed to the industry of a breed of cats left here by European ships." In the same log entry Bligh recorded the first reference to cats on the *Bounty* when he wrote: "We were constantly obliged to be at great pains to keep the ship clear of vermin on account of the plants. By the help of traps and good cats, we were freed from rats and mice" (Bligh, 1792/1979, p. 121). Bligh was referring to his requirement to clear the ship of rats before bringing aboard the cargo of breadfruit plants that the *Bounty* had been tasked to obtain. But in spite of the importance of cats on ships, Sir Joseph Banks instructed Bligh that there were to be no animals such as dogs, cats, or goats on board during the transport of the breadfruit plants unless they were caged to be used as food during the voyage ("Letter by Banks to an unknown correspondent", as cited in Alexander, 2003, p. 50). On March 27, 1789, Bligh ordered that all the ship's cats and dogs be taken ashore prior to the loading of the breadfruit. When the *Bounty* departed Tahiti on April 5 with its cargo of breadfruit there were no cats aboard (Alexander, 2003, p. 124).

The mutiny occurred on April 28, 1789; Bligh and his loyal crew members were set adrift in a longboat. James Morrison was the boatswain's mate on the *Bounty*. He claimed loyalty to Capt. Bligh, but due to lack of space in the longboat, he remained on the *Bounty* with the mutineers until their final stop in Tahiti. Eventually he was arrested and taken back to England where he was tried and convicted, and later pardoned (Kirk, 2008, p. 43).

In Morrison's journal describing the *Bounty's* stay in Tahiti and the subsequent mutiny, he wrote of the Tahitians: "They have also cats and rats but eat neither" (Morrison, 1792/2010, p. 136), and that "they charge us with several other disorders with which they say they were unacquainted before they knew us, particularly with bringing fleas among them, which they say were brought by the cats" (p. 216).

Immediately after the mutiny, the mutineers sought refuge on the island of Tubuai. They arrived on May 24, stayed for a week, and then returned to Tahiti to pick up nine women, eight men, eight children, and some livestock, including some cats, to take back to Tubuai (Alexander, 2003, p. 13). Morrison wrote of the Tahiti visit: "By the 16th we had mustered about 460 hogs (mostly breeders), 50 goats, a quantity of fowl, and a few dogs and cats" (p. 47). Some of those cats were left on Tubuai, as indicated by Morrison's July 18, 1789, entry: "Finding the place overrun with rats, several cats were

[3] The *Dolphin* is regarded as the first European ship to reach Tahiti.

brought on shore and let loose among them" (p. 51). Describing the living conditions of the Tubuai people, he wrote: "The rats run over them all night in droves, but as we left several cats, it is possible that in time they may reduce their numbers" (pp. 61-62).

On Sept. 15, 1789, the mutineers left Tubuai for the second and last time to return to Tahiti, "well stocked with hogs, goats, fowl, dogs, and cats…" (p. 58). Fifteen of the *Bounty's* crew, including Morrison, disembarked in Tahiti and were eventually apprehended by British authorities. On the night of Sept. 21, 1789, the *Bounty*, under the command of Fletcher Christian, departed Tahiti on the voyage that would eventually end at Pitcairn Island around Jan. 15, 1790 (Kirk, 2008, p. 39).

To summarize: we know that most ships in the 1700's were rat infested and carried cats to keep them under control. Cats were present on the *Bounty* prior to loading the breadfruit and again when the mutineers obtained livestock and cats in Tahiti following their first attempt to settle at Tubuai. They also had cats aboard when they left Tubuai for the second time on Sept.15, 1789, to return to Tahiti. Cats were important enough to be mentioned several times by Morrison and were regarded by the mutineers as necessary for rat control. We conclude that the *Bounty* must have had cats aboard when the mutineers departed Tahiti for the last time on the night of Sept. 21, 1789, (only 6 days after Morrison had reported the *Bounty* to be "well stocked with …cats...") to eventually find their way to Pitcairn Island about 4 months later. There is no known written account giving details of the *Bounty's* arrival at Pitcairn, but the journal of Mr. Newell, first officer of the *Sultan* in 1817, and the notes made by J. A. Moerenhout in 1829 (discussed in the next section) both state that Pitcairn islanders told them that cats had arrived with other livestock on the *Bounty*. Thus, there appears to be compelling evidence that cats were first transported to Pitcairn Island by the *Bounty* mutineers.

19th Century: Protecting the cats

Nothing more was heard from the mutineers until they were discovered on Pitcairn by Captain Folger of the *Topaz* in 1808. At that time the island was populated by John Adams, last survivor of the original mutineers, and a group of women and children who were the mutineers' partners and offspring (Kirk, 2008, p. 49).

The first official documentation of cats on Pitcairn Island was logged during the visit of the American whaler Sultan under Captain Reynolds of Boston. It was the third ship to arrive since the mutineers' hideout had been found in 1808 by Capt. Folger. The ship's first officer, Mr. Newell, wrote a description of Pitcairn in his journal. Part of the entry for Oct. 17, 1817 states: "The principal produce of the island is yams, tarro, bread fruit, cocoa nuts, bananas, sugar cane, and the tea root, all of which they found on landing – they also found great numbers of rats. Hogs, goats, fowls, and cats were brought in the ship" (Topliff, 1821). "The ship" in this context is understood to be the *Bounty*.

Jacques Antoine Moerenhout[4] visited Pitcairn Island in January of 1829 on the *Volador* and made detailed notes about his visit. His observations include the following paragraph, of great significance to Pitcairn cat history:

[4] J. A. Moerenhout later served as both the U.S. and French Consul in Papeete, Tahiti.

> One thing which astonished me and upon which I remarked to my guides is the few birds on the island because, having covered it almost completely, I had seen only two or three -- and these were sea birds. "It's the cats," they told me, "who have destroyed them." It seems that upon the arrival of the English the island was covered with rats, which the cats which they had brought with them took no time in chasing, but, since they were given nothing to eat so that they would more readily chase the rats, they multiplied rapidly, becoming wild. A few years later they were so great in number that, not content with destroying the rats, they also destroyed the birds, which they surprised at night, and when these resources were lacking, they could even be seen taking away the chickens of the inhabitants. Soon then they had become even more inconvenient than the rats had ever been, and the islanders were obligated to give chase to them with guns and set traps for them, and thus destroyed almost all. If they had not done this, the cats would not have left a single chicken in all the island. (Moerenhout, 1993, p. 27)

In Moerenhout's quote, "The English" refers to the original mutineers who were from England, as opposed to their Polynesian/English descendants born on Pitcairn.

In 1831 the entire Pitcairn population abandoned the island during an attempt to resettle in Tahiti. Many islanders died from illnesses there. The survivors decided to return to Pitcairn and some arrived after only 3½ months away (Kirk, 2012, pp. 79-81). In 1834 Frederick Bennett visited Pitcairn on HMS *Tuscan* and wrote that "The quadrupeds we noticed were all exotic, as goats and swine, which were brought hither by the first settlers from the *Bounty*, and a bull and cow, a donkey, a dog, and several cats, which the people had recently brought with them from Tahiti…" (Bennett, 1840/1970, p. 40). His wording suggests that cats were brought to Pitcairn from Tahiti after the failed attempt to resettle there in 1831. It raises a question: Does this mean that Pitcairn was without cats in 1831? We propose that the earlier partial cat eradication noted by Moerenhout, while not eliminating all cats from the island, might have reduced their numbers to a level that allowed the rat population to greatly increase by the time the islanders' exodus to Tahiti took place.[5] Thus, the Pitcainers might have obtained additional cats in Tahiti, where they were readily available.

Cats were noted to be present on Pitcairn in December, 1837 (Hay, 1898, p. 339). By the late 1830's the islanders were making the welfare of cats a high priority, representing a dramatic change from the earlier eradication efforts described by Moerenhout. On Nov. 30, 1838, at the request of the Pitcairn Islanders, Captain Russell Elliott of HMS *Fly* wrote a set of laws for Pitcairn Island. The third law was described as "Laws for Cats" which stated:

> If any person under the age of ten years shall kill a cat, he or she shall receive corporal punishment. If any one between the ages of ten and fifteen shall kill a cat he or she shall pay a fine of twenty-five dollars; half the fine to be given to the informer, the other half to the public. All masters of families convicted of killing a cat shall be fined fifty dollars; half the fine to be given to the informer, the other half to the public. (Brodie, 1851, p. 86)

Fines of up to $1200 in today's dollars show how critical cats must have become for rat control. It is noteworthy that the laws were directed toward the actions of young people.

[5] After feral cats on Pitcairn Island were eradicated in 1997, the population of rats exploded, forcing islanders to reintroduce cats from New Zealand to control them ("The Rats and Cats of Pitcairn," 2000).

Walter Brodie was stranded on Pitcairn for 2 weeks in 1850 and described seeing "cats numerous, and wild in the bush, and are encouraged to kill the rats, although they probably destroy more fowls than rats" (Brodie, 1851, p. 47). Another description of Pitcairn Island states: "The people are annoyed by rats, which do much damage to the sugar-canes. Hence the strictness of the Law for the Preservation of Cats" (Murray, 1853, p. 108). One of these laws is described by Rev. G. H. Nobbs:

> If a cat is killed without being positively detected in killing fowls, however strong the suspicion may be, the person killing such cat is obliged, as a penalty, to destroy 300 rats, whose tails must be submitted for the inspection of the magistrate, by way of proof that the penalty has been paid. (Murray, 1853, pp. 257-258)

In 1856 the people of Pitcairn abandoned their island again and resettled on Norfolk Island. All 194 islanders left Pitcairn on May 3, 1856, aboard the *Morayshire* and arrived at Norfolk Island on June 8 (Kirk, 2008, pp. 116-117). Prior to this time, domestic cats were present on Norfolk and were mentioned in a journal entry on May 16, 1855 (Stewart, 1992, p. 29). However, we could find no historical references suggesting that cats were taken from Pitcairn to Norfolk. None of a set of surviving journals of Pitcairn Islanders who resettled on Norfolk Island make any mention of cats being brought from Pitcairn, nor is there any mention of cats in a transcribed letter from Norfolk Islander Fredrick Howard to his sister, in which he speaks of his time spent with the Pitcairn Islanders while establishing their Norfolk settlement (Leah Honeywood, personal communication, Dec. 14, 2018). During the resettlement to Norfolk Island, Pitcairn Island sat deserted for around two and one-half years with the exception of March 15 – July 23, 1858, when it was occupied by Captain Knowles and six crew members of the ship *Wild Wave*, which had run aground at Oneo (Kirk, 2008, p. 120). Captain Knowles reported in his log that they found cattle, goats, chickens and one hog to sustain them but mentioned neither rats nor cats (Knowles, 1858/1957).

However, we know from Walter Brodie's description that there were "numerous" feral cats on the island in 1850. Additionally, a later newspaper account mentioned that the *Wild Wave* crew encountered cats on Pitcairn ("A Romance of the Sea," 1875), although the article appeared to contradict some statements Captain Knowles made about the incident in his log. If the islanders took cats with them to Norfolk Island, those cats probably were tame pets that could have been easily caged and transported rather than feral cats that would have been much more difficult to catch and handle. Any pet or feral cats remaining on the deserted island would have had no difficulty surviving the absence of people due to the mild climate, lack of predators, abundant food in the form of rats and birds, including chickens, and abandoned structures for shelter. A deserted Pitcairn Island would have been a virtual paradise for cats. Thus we do not believe that the abandonment of Pitcairn interrupted the presence of cats on the island.

On Sept. 8, 1878, Rear Admiral De Horsey of H.M.S. *Shah* arrived at Pitcairn. In a report he wrote dated Sept. 17, 1878, he said of the islanders: "They have a few sheep, goats, pigs, fowls, cats, and dogs" (Young, 1894, p. 206). His report went on to state that the "sheep, goats, pigs, fowls, dogs, and cats…are entirely free from the maladies that sometimes affect their kind" ("A Real Utopia," 1878). In Nov. 1878, Captain Samuel C. Jordan was told by the wife of the pastor, Simon Young, that the Pitcairn islanders were troubled by rats eating sugar cane and sweet potatoes. They had bred cats to control the rats but

"the cats, too, became a nuisance, and in their turn destroyed the chickens and young ducks" (Jordan, 1879). On July 20, 1889, Captain Charles E. Barker of the U.S.S. *Abardena* entered in the ship's log: "We got a little yellow cat from the Pitcairn people and it's getting quite used to us now" (Ford, 2012, p. 66). In 1892 there were reported to be "wild goats and wild cats, the latter a great nuisance, because of their fondness for chickens" ("The Pitcairn Islanders," 1892).

A law concerning cats appears in the Pitcairn Island Civil Recorder dated January 1, 1893, and is quoted in its entirety below:

> Law Sixteen (16). Any person or persons after this date, September 24, 1884, maliciously wounding, or causing the death of a cat, without permission, will be liable to such punishment as the court will inflict. Further, any person, or persons aiding, or abetting in the aforesaid misdemeanor, will also be convicted under the same indictment. Should any dog, going out with his master, fall in with a cat, and chase him, and no effort be made to save the cat, the dog must be killed for the first offence. Fine 10 shillings. Cats in any part of the island doing anyone damage, must be killed in the presence of one of the members of parliament. (Shapiro, 1936, p. 294)

Thus while cats still had great importance for rat control, troublesome cats would not be tolerated.

For completeness, we include an earlier version of the above cat law dated Sept. 9, 1878, described in an 1899 Australian newspaper article as "deliciously quaint in its provisions and language":

> No person or persons are to kill any cat unless doing him damage. If anyone be found so doing, he will be punished by having his dog taken from him and be killed; and should the person have no dog, he shall be punished by the magistrate. Should a dog go out with his master and fall in with a cat and chase him, and the owner of the dog make all effort to save the cat, this will save his dog, though the cat died afterwards; but should no effort be made to save the cat, the dog must be confined for the first offence, and be killed for the second. ("The Pitcairn Islands," 1899)

There are relatively few nineteenth and twentieth century references about Pitcairn that contain more than a passing mention of cats. Some visitors to the island who made an effort to write detailed descriptions made note of their presence, but many others mentioned nothing about animals at all, or wrote only of livestock used as a food source. Visitors who landed on the island for only a short time could have easily missed seeing cats or may have thought them unworthy of mention when compared to the human drama around them. However, the Pitcairn "Laws for Cats" were widely publicized in a number of magazine and newspaper articles. Cat laws along with other laws concerning Pitcairn animals were seen by the outside world as indicative of a quaint and innocent way of life.

20th Century: Managing the cats

From the late nineteenth century through the first decades of the twentieth century, island court records and official reports recorded conflicts and disagreements between islanders concerning the behavior of animals, while "rats and wild cats created other problems" (Silverman, 1967, p. 175). Cats were seen on Pitcairn in July 1907 ("Pitcairn Island and its People," 1908) and their presence was also mentioned by a resident missionary in 1917 (Pitcairn Island People Happy, 1917). In June 1921 a visitor reported that "there are plenty of… wild chickens, not to mention wild cats, on the island. The islanders, of course, are not without their tame cats" ("Pitcairn Island," 1921). Cat laws continued to be publicized,

and headlined a 1937 article in the *Sydney Morning Herald* (Alley, 1937). Edwin Ferdon Jr. visited Pitcairn in 1956 and noted "Dogs are numerous in the village, and a few cats are kept as pets." (Ferdon, 1958, p. 76). In March 1960 an informal census of random items and animals on Pitcairn listed that there were "cats unnumbered" (Ford, 1980, p. 135). In November 1962 the Pitcairn Islanders reported, "Wild cats are causing quite a lot of death amongst young chickens, so that any cat seen prowling around fowl is usually given a short shift." The term "short shift" apparently means that the cats were shot. The report continues by stating that an islander identified as Roy Clark "became so concerned about the 'trigger happiness' of some of the boys that he made a special trip down to the pictures the other night to give a full description of his cat so it could be recognized and spared" (Ford, 1980, p. 92). This mention of the "trigger happiness" of boys is noteworthy because it recalls the laws for cats of 1838 that established large fines for families of children that killed a cat. In January 1977 the Pitcairn people did another informal census of animals on the island and estimated that there were 47 tame cats (Ford, 1980, p. 18). No mention was made of wild (presumably feral) cats.

Cats and other introduced species on islands worldwide have become increasingly recognized as threats to the ecosystem of these islands. Feral cats are believed to have caused breeding failures and extinctions in numerous endemic species, including birds, mammals, and reptiles. Since the beginning of the twentieth century there have been cat eradications performed on around 100 of the world's islands with a success rate of approximately 80% (Campbell et al., 2011). In 1997 the British Government and the World Wildlife Fund (UK) contracted with a New Zealand company called Wildlife Management International Limited (WMIL) to exterminate the brown rats (*Rattus exulans*) and feral cats on Pitcairn Island. The project was funded by the Department for International Development and Worldwide Fund for Nature (UK) (Bell & Bell, 1998).

The WMIL team stayed on Pitcairn from April 13 – Dec. 4, 1997, to perform the task. The Pitcairn Islanders nicknamed the extermination team "The Rat Pile." Rats were targeted with an anticoagulant rodenticide that was placed along a dense network of cleared "grid lines" cut through the entire island, approximately 25 meters apart. The Pitcairn cats were broken into three groups: (1) pet cats for breeding; (2) pet cats to be spayed or neutered and returned to their owners; and (3) feral cats to be put down. Three unspayed females and two unneutered males were saved for breeding and were kept in pens at two homes while the eradication was in progress. Residents were free to claim any cat on the island as their pet and request that it be sterilized by a veterinarian (brought from New Zealand as part of the WMIL team) and released to them instead of being put down. All pet cats and 17 feral cats were tested for feline aids (FIV) and feline leukemia (FeLV) and found to be negative, leading the veterinarian to conclude that the island was free of both diseases (Bell & Bell, 1998).

A total of 45 feral cats were trapped, 25 in leg hold traps and 20 in cage traps. Another 11 feral cats died from secondary poisoning caused by eating rats that had ingested the rodenticide. Six more feral cats were shot and one was killed with a machete. Thus a total of 63 feral cats were known to have been eliminated during the eradication. An estimate for the total Pitcairn feral cat population prior to the eradication was given as more than 70 (Nogales, 2004) because it was assumed that a number of cats that had died from secondary poisoning were never located and accounted for (Elizabeth [Biz] Bell, personal communication, Aug. 23, 2018). Altogether, 24 pet cats were spayed or neutered and 5 were

allowed to remain fertile for future breeding, initially leaving the island with 29 cats. However, WMIL's pet cat data shows that up to 10 of those 29 cats died while the team was still on the island (two from fight wounds, one from poisoning, one put down due to allergies, one put down for unspecified reasons, and five missing/presumed dead - probably from poison), leaving only 19 cats, including the five that were reserved for breeding. Two pet cats were poisoned but they recovered after treatment with an antidote containing vitamin K1 (Bell & Bell, 1998).

The WMIL eradication team proposed to the Island Council that it adopt a "cat ordinance" and appoint a "Cat Officer" to enforce it. The cat ordinance, reminiscent of the Laws for Cats of the 19th century, required that all pet cats be "de-sexed" except for "two breeding groups." The breeding cats would be cared for by two families to be selected by the Cat Officer. Kittens born to the breeding cats were to be neutered if male and put down if female, as would "surplus" male kittens, unless the Cat Officer authorized a kitten to "remain entire" for future breeding. Breeding cats would be limited to three females and two males. Island families would normally be limited to two pet cats but could apply to own more "under special circumstances." The limitation on pet cats would not apply to cats already kept by families. Any family leaving the island would be required to have someone else care for their cats or arrange through the Cat Officer to have them put down. The ordinance went on to encourage the killing of any stray or feral cats missed by the eradication program and to provide guidance for permissions needed to import a cat to the island (Bell & Bell, 1998). There is no indication that the suggested cat ordinance was ever adopted by the Island Council and there is no reference to a cat ordinance on the Pitcairn government website.

WMIL returned to Pitcairn from April 12 – Sept. 27, 1998, in order to complete the rat eradication program and to assess the results of the feral cat eradication program. Although it appeared that the cat eradication had been successful, the islanders' attitude toward the program had completely changed and they now had "an extremely strong negative feeling" about any further attempt to eradicate cats, should additional cats be found. This was, they said, due to the secondary poisoning of pet cats and the "loss of breeding potential due to the de-sexing carried out in 1997." As a result, the team limited their activities regarding cats to inspection of the island for signs of feral cats (Bell, 1998).

The Pitcairn Islanders did not inform the eradication team of any concern they might have had about the ancestry of the cats that were targeted by the eradication program (Elizabeth [Biz] Bell, personal communication, Aug. 23, 2018). An unintended consequence of the eradication and the spaying/neutering of nearly all pet cats was that any extant "original" genetic line of cats, sometimes referred to as "Bounty Cats" by the Pitcairn Islanders, probably was terminated (Steve Christian and Kevin Young, personal communications, May 30, 2018). The perceived loss of a line of original cats was disturbing to a number of residents. For example, a Pitcairn Islander posting to an internet discussion board using the screen name "Maimitihaven"[6] stated that "The spaying of cats was done when the 'rat pile' was here in (19)98.[7] The saddest thing is our true Bounty Cats were shot, neutered/spayed until there [weren't] any breeding ones left" (Maimitihaven, 2005). Maimitihaven added in the same post that "What was left to breed [were] poisoned by eating the poisoned rats, and medication didn't reach

[6] "Maimiti Haven" is the name of a residence on Pitcairn Island.
[7] The cat eradication and spay/neuter program was performed in 1997.

the dying cats when they crawled off to die." WMIL confirmed that the cats saved for breeding did not live very long after the departure of the eradication team but was unsure of the reason for the deaths of the relatively young cats (Elizabeth [Biz] Bell, personal communication, Aug. 23, 2018). A Pitcairn islander currently living off the island, but who was living on Pitcairn at the time of the eradication, wrote in an email that she had a fertile female cat and was "hoping to get some kittens from her," but that the cat "eventually succumbed to secondary poisoning, as did most of the domestic cats" (Anonymous, personal communication, Nov. 15, 2018).

In 1999 rats began to reappear on Pitcairn in spite of the follow-up work done in 1998 (Bell, 1999). By July 2000 there was an explosion of the Pitcairn rat population. A number of residents began shooting the rats with .22 rifles and killing as many as 200 rats in only a few days. They also obtained more rat poison but found it difficult to use in wet weather. Traps were employed but were still insufficient to keep the rat population from growing. The rats were eating nearly all types of fruit and vegetables grown on the island, so it was decided to bring a pair of breeding cats from New Zealand. Those cats soon produced seven kittens and they were all given the rodenticide antidote to protect them from poisoned dead rats ("The Rats and Cats of Pitcairn," 2000).

21st Century: Cats into the future

Maimitihaven complained that the new cats brought in from New Zealand were "lazy" and would not chase rats. She added that the new cats had been introduced in 1999/2000, and "some of the cats raised were set off into the wild to help get rid of the rats." Thus feral cats were reintroduced to Pitcairn around 2000. A 2010 review of invasive species impacts in UK overseas territories confirmed that cats had been reintroduced (Hilton et al., 2010) and as of 2016 were present in "low numbers" (Schofield et al., 2016).

In 2016 a report issued under the Royal Society for the Protection of Birds (RSPB) for the "Darwin Project" revived the discussion about rat and cat eradication on Pitcairn Island. The project manager was named as Dr. Grant Harper. The report states that "biodiversity of Pitcairn could be increased if rats and cats were eradicated. Birds such as the endangered Pitcairn reed warbler (*Acrocephalus vaughani*) would benefit. Any such eradication project would require full engagement of the community with external organizations taking a 'back-seat'." The report also describes the economic impact of invasive species on Pitcairn as "minor" compared to challenges of sustaining such a small, isolated population. During a visit to Pitcairn by Darwin Project personnel, a feasibility study for a rat and cat eradication was completed. However, no action has been taken. Some residents of Pitcairn do not want cats eradicated until the island is free of rats. They have not forgotten the failed rat eradication effort in 1997-1998 when the rat population exploded following the successful eradication of feral cats. They are also concerned about pet cats being poisoned. However, it appears nearly impossible to protect the cat population because the techniques used to eliminate rats also indirectly affect the cats. The feasibility study and an operational plan remain unpublished out of concern that the Pitcairn community might view their publication as intention to act without local approval and could result in "uncontrolled rumors" in the community (Kelly, 2016).

The 2018 Field Study

Motivation and goals

This study was motivated by the need for both historical and current information on the cats of Pitcairn Island. Up until now, the only significant publications about the Pitcairn cats have been two reports published in 1998 by WMIL to document their rat/feral cat eradication project. The reports are extremely thorough and contain a wealth of information about the cats on the island at that time. However, because the scope of the reports was limited to the eradication project, they do not provide an overview of the cat population historically or currently.

Our primary goals were to conduct a census of the cats on Pitcairn Island (both pet and feral), describe their observed distribution and condition, and infer the dynamics and possible future using current and historical data. We also examined interactions between the human and cat populations and assessed islanders' attitudes toward the 1997 feral cat eradication.

Definitions

The conventional definition of a "feral cat" is that it lives outdoors and does not socialize with humans. Feral cats sometimes live far from any humans, but also may live in the vicinity of buildings and human activity. In all cases they fend for themselves and try to avoid interaction with people. Feral cats originate from pet cats that are released (or abandoned) by their owner into the outdoors, cats that escape from their owner, or cats that result from unrestrained breeding (Nogales et al., 2013). If the kittens of those cats experience no contact with humans during the third to eighth weeks of life, they probably will become feral (Bradshaw et al., 1999).

Cats that live with humans are referred to as "house cats" or "pet cats." Pet cats usually are highly socialized to their owners and may seek frequent physical contact. Finally, there are less socialized cats that live mostly outdoors but are fed by people and interact with them to some extent, but don't usually allow themselves to be touched. These cats are often called "semi-feral" or "stray." In this paper we will use the term "pet cat" to refer to all cats on Pitcairn that are *not* feral, so this includes semi-feral cats.

Methods

To document the pet cats, we interviewed residents and visited the two households with the largest numbers of pet cats. While we did not visit all the households with pet cats, we believe we recorded a complete list of cats for all households.

To document the feral cats we used a Blusmart wildlife (trail) camera which we placed in nine different locations during the study period. Bait (generally cooked or raw fish plus a commercial kibble) was placed in locations thought to be frequented by feral cats. The location of each trail camera site was recorded with a Garmin GPSmap 62s. In addition, brief personal sightings of suspected feral cats were recorded. We used ordinary photography to capture images of cats when encountered anywhere on the island. All photographs from all sources were analyzed to identify every distinguishable cat.

Observations of pet cats

Table 1 lists numbers of pet cats at ten residences. For an explanation of "Zone" numbers see the next section. In order to respect privacy, we have omitted names and locations–we simply assigned a lower case letter to each residence known to have pet cats. We had the opportunity to visit residences "a" and "b" to observe the cats.

Table 1 – Pet cats at island residences in 2018

Residence	Zone	Humans	Pet cats
a	1	3	4
b	6	4	9
c	1	1	1
d	1	1	1
e	1	2	2
f	1	2	1
g	1	2	1
h	1	2	2
i	1	2	3
j	1	3	1
Subtotal Zone 1		**18**	**16**
Subtotal Zone 6		**4**	**9**
Total		**22**	**25**

In 2018 there were 23 residences on the island occupied by 42 Pitcairn Islanders and around 8 temporary contractors. Twenty-two of the 42 Pitcairners occupied the 10 residences that had 1 or more pet cats. Among cat owners the mean was 2.2 humans/residence and 2.5 cats/residence. Thus, there was close to 1 cat per human in those 10 residences. The contractors had no pets.

The trail camera sometimes recorded pet cats. The information obtained by the interviews and visits helped exclude these records from the feral cat records.

Observations of feral cats

Information on feral cats was obtained using the trail camera and opportunistic sightings. **Table 2** lists the number of distinct feral cats that were photographed by the trail camera in each of nine sites. The sites were assigned sequential numbers (**1-9**) and descriptive names, listed in Table 2 and shown on **Plate 1**. We divided the island into six zones of approximately equal area, numbered clockwise from Bounty Bay, and these are noted for each camera site. **Plates 2-10** show views at or near the locations where the trail camera was deployed. **Plates 11-19** show a selection of trail camera images of feral and pet cats.

Table 2 does not include any cats that were known to be pet cats. However, it is possible that one or more cats counted in Table 2 could be roaming pet cats that were not known to us.

Table 2 – Trail camera counts of distinct feral cats. Known pet cats are excluded.

Site #	Name	Latitude	Longitude	Zone	Start time/date	End time/date	Cats
1	Adam's Ground	-25.067986	-130.102489	**1**	21:21/2018-05-24	10:49/2018-05-25	5
2	Big Fence	-25.067355	-130.098039	**1**	12:13/2018-05-25	07:30/2018-05-26	1
3	Flatland	-25.068307	-130.10547	**6**	16:31/2018-05-26	11:10/2018-05-27	6
4	St Paul's Road	-25.072585	-130.096922	**2**	18:01/2018-05-28	12:01/2018-05-29	5
5	Steve's Garden	-25.074483	-130.103665	**3**	20:00/2018-05-29	13:18/2018-05-30	1
6	Nig's house	-25.064953	-130.104123	**6**	19:47/2018-05-30	08:30/2018-05-31	4
7	Tedside	-25.066434	-130.120662	**5**	11:42/2018-05-31	09:07/2018-06-01	1
8	Bounty Bay	-25.069924	-130.09365	**2**	17:18/2018-06-01	07:57/2018-06-02	2
9	Tennis court	-25.073607	-130.099164	**3**	16:36/2018-06-02	11:24/2018-06-03	0
						Total	**25**

Table 3 lists sightings of cats believed to be feral. These sightings were mostly fleeting glimpses of cats crossing roads and disappearing into the undergrowth. One of these sightings was reported by a resident. It is possible that any of these cats could be roaming pets not known to us that are also listed in Table 1, or feral cats listed in Table 2. We believe that a cat sighted on May 27, 2008, was also recorded by the trail camera at Site 4 and is accounted for in Table 2, hence we count only 7 distinct feral cats rather than 8 (see * in Table 3).

Table 3 – Sightings of (presumed) feral cats

Date	Location	Zone	Observation	Cats
2018-05-27	In forest beside St. Paul's road	**2**	Black/white - Believed to be a cat seen on trail camera at Site 4	*
2018-05-31	On Tedside road near site 7	**5**	White/ orange – distinctly different cat from Site 7 trail camera image	1
2018-06-01	On Tedside road near Adamstown	**6**	Longhair fluffy/dark color	1
2018-06-01	Near Adamstown shop	**1**	Dark tabby	1
2018-06-02	Steve Christian's garden	**3**	Group of kittens eating an avocado, reported by Steve Christian	3
2018-06-02	Top of Hill of Difficulty	**1**	Brief distant sighting – no accurate description	1
			Total	**7**

Summaries of cat observations

We now combine the pet and feral cat observations to obtain the total observed cats, and list them together with the observations made during the 1997 eradication. **Table 4** gives the geographical (zonal) distribution of feral and pet cats in 1997 and 2018, the only two years for which such data exists. The 1997 data were based on the locations where (presumed) feral cats were trapped, killed, or where remains of poisoned cats were found by WMIL (Bell & Bell, 1998). The 2018 data (current study) are based on the locations where feral cats were briefly sighted or photographed at a camera trap site (cf., Tables 2, 3).

Table 4 – Distribution of observed cats

	1997			2018		
Zone	**Pets**	**Ferals**	**Total**	**Pets**	**Ferals**	**Total**
1	24	11	35	16	8	24
2	0	7	7	0	7	7
3	0	14	14	0	4	4
4	0	11	11	0	no data	0
5	0	5	5	0	2	2
6	5	15	20	9	11	20
Subtotal	**29**	**63**	**92**	**25**	**32**	**57**
"Unobserved"			**7**			**10**
Total cats			**99**			**67**

The following remarks refer to various entries in Table 4.

During the 1997 eradication, the WMIL team reported that 5 pet cats were kept for breeding and 24 were spayed/neutered, i.e., a total of 29 pet cats. This number is listed in the table as "**Pets**." The team eliminated 63 feral cats (listed as "**Ferals**"). They also assumed that at least 7 bodies of poisoned cats were never located. That number is listed in Table 4 as "**Unobserved**."

In the present study (2018) we identified 25 pet cats and 32 feral cats. However, we also believe that we overlooked a number of feral cats. Due to our limited time in the field we did not survey Zone 4 at all, and during one of the two camera observations in Zone 3 there was heavy rain all night which degraded the attractant bait. We can, however, estimate the number of undetected cats by removing Zones 3 and 4 from the data set and finding that the number of feral cats decreased by 26% from 1997 to 2018. Applying this change to 1997 counts for Zones 3 and 4, we infer 18 feral cats in Zones 3 and 4 in 2018. However, we also consider that Zones 3, 4 and 5 are a little more isolated from Adamstown and human activity than Zones 1, 2, and 6. In Zone 5 we found 60% fewer cats than were seen in 1997. If we apply that percentage to the 25 cats found in Zones 3 and 4 in 1997 we would infer 10 cats in Zones 3 and 4 in 2018. Since we counted only 4 cats in those two zones, we infer that we overlooked between 10 - 4 = 6 cats and 18 - 4 = 14 cats. The mean of these two estimates is 10 cats, and these are listed in Table 4 on the "Unobserved" Line.

The following observations emerge from Table 4: The number of pet cats in 2018 was 25/29 (86%) of the number in 1997, while the number of feral cats in 2018 was 42/70 (60%) of the number in 1997. The total number of cats on Pitcairn in 2018 was 67/99 (68%) of the number in 1997 prior to the eradication.

Thus, we find that there are about as many pets cats in 2018 as in 1997, but there are only about half as many feral cats. We do admit that our trail camera records may have missed additional feral cats, which could bring the feral and pet cats into rough parity for the two years.

Table 5 lists all known population data for Pitcairn Island cats.

Table 5 – Human/Cat population data

Year	Ferals	Pets	Total cats	Total humans	Ferals per Pet	Ferals per Human	Pets per Human	Cats per Human
1977		47		70			0.7	
1997	70	29	99	40	2.4	1.8	0.7	2.5
2018	42	25	67	42	1.7	1.0	0.6	1.6

From Table 5, in both 1997 and 2018, roughly one third were pets and two thirds of the cats were feral. The ratio of pets to humans is nearly the same for the three years for which data are available. This roughly constant ratio defines a simple rule of thumb: for every 2 pet cats on Pitcairn there are 3 humans. Also, from Table 1, roughly half of the residents live in households with at least 1 pet cat, and there are (on average) about as many pet cats in those households as there are people.

The 2 to 3 ratio of pet cats to humans on Pitcairn greatly exceeds the ratio for all large, highly populated countries. **Figure 2** shows the ratio for Pitcairn and ratios for some of the large countries of the world (note log scale on the ordinate). There is a weak trend as the human population increases, people have relatively fewer cats. Pitcairn, with a comparatively tiny population, has a relatively very high ratio of pet cats to humans.

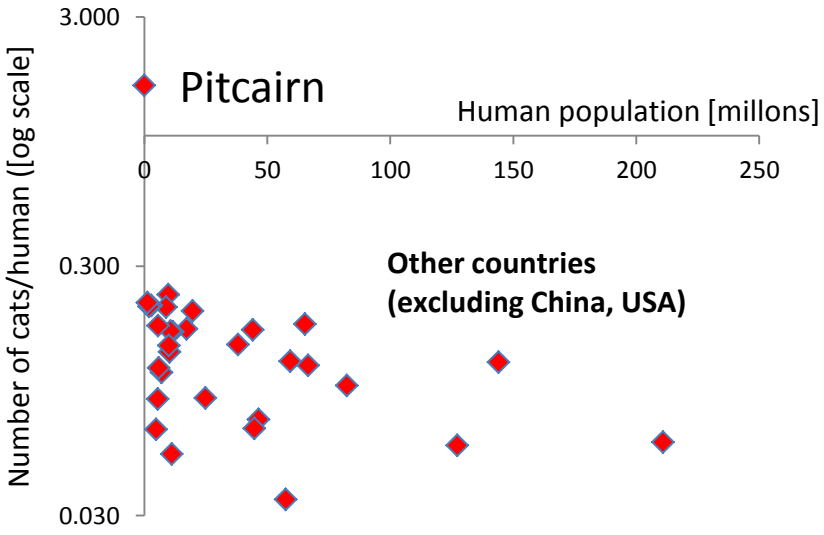


Figure 2 – Ratio Number cats/Number of humans for Pitcairn Island and several large countries ("Countries in the World…,"2018; "Countries with the most pet…," 2017)

Can we account for the high cat/human ratio on Pitcairn? Pitcairn is a rural community, and rural areas in general have higher pet ownership rates per household than urban areas (Aegerter et al., 2017). Pitcairn also has a long tradition of valuing cats for rat control, and they were brought to the island as recently as 2000 for that purpose. Perhaps some islanders feel a bit insecure without their cats, knowing how an increasing rat population can seriously damage crops, and with awareness that world events could lead to a reduction in food imports if shipping is affected. However, the rough 1-1 ratio of cats to humans in homes with cats suggests that for most Pitcairners, 1 or 2 cats are generally enough.

Physical condition of the cats

In 1878, Rear Admiral De Horsey of H.M.S. *Shah* wrote that the animals of Pitcairn, including cats, "are entirely free from the maladies that sometimes affect their kind." A similar observation was made in 2012 (*Shelling*, 2012). In 1997 a veterinarian found that the island was free of feline aids (FIV) and feline leukemia (FeLV). The cats we observed and photographed appeared healthy and showed few signs of conditions that commonly plague outdoor cats in other parts of the world, such as upper respiratory infections, inflamed eyes, and skin problems. They appeared to be well fed and of a healthy weight. Some Pitcairn cats, such as a >20 year old male called "Rafiki," have had exceptionally long lifespans, which is unusual for a cat that lives mostly outdoors and gets no veterinary care. A young cat called "Hopper" had one leg seriously injured by a crab when a kitten, but is now able to function well on 3 legs, with the injury fully healed.

Cats experience minimal danger from the ATV's that ply Pitcairn's roads, and the mild climate provides an ideal environment for cats. However, isolation is probably the cats' key advantage. Pitcairn Islanders have long been known to be healthy people, although the arrival of a ship often spreads illness through the community (Kirk, 2008, p. 99). We speculate that the same situation exists for cats; Pitcairn's Isolation and the infrequency with which cats are brought to the island protect the existing population from communicable feline diseases.

Cat/human interactions

[Out of respect for Pitcairn islanders' desire for privacy, we omit the names of cat owners and sources of personal communications.]

Plates 20-22 show some photographs of pet cats.

Pitcairn Islanders' relationship with their cats is for the most part typical of any rural community. A number of cats on the island are treated like pet cats elsewhere in the world, in that they receive attention and affection, are allowed inside the house where they can sleep, and are fed regular meals. Normally these pets are not confined inside a house but are allowed to roam at will.

The Pitcairn cats uphold their traditional job as rat catchers. We witnessed a young male cat coming into a house with a live rat in his mouth. The home owners showed no surprise or concern and allowed the cat unlimited play time with the rat. The cat later carried the rat into the basement, also without the slightest objection from the homeowners.

There are also many semi-feral cats that people feed regularly and allow into their houses. In several cases we found that residents feed both tame and semi-feral cats together and consider them all to be

pets, even though the semi-feral cats will not usually accept physical contact. All of these cats have names. Due to Pitcairn's mild climate many houses have their doors standing open most of the time, allowing the cats to come and go as they please. One residence with several cats has been without a back door since it was destroyed by termites some years ago; it is always open to the outdoors. On the wall of that house was a child's drawing of a cat named "Animal" from around twenty years earlier, bearing the caption "Pitcairn's oldest cat."

As in any community, not all people interact with cats. Some avoid them due to health issues or because they simply dislike cats. One islander who stated that he "can't stand cats" still accepts three cats being at his home because of his wife's preferences. Another resident stated that he is allergic to cats. He knew little about the local cats and when pressed for an estimate, conjectured that there might be a thousand of them on Pitcairn! One family has nine cats, which receive much attention from two young daughters. A third young girl on the island also has a cat. Several other households have from one to four cats. The temporary workers and contract personnel do not have cats and are discouraged from doing so because of the problem of what to do about the cats when they leave the island at the end of their contracts. Currently there are no dogs on the island.

Sometimes residents with cats leave the island for extended periods of time. It is not unusual for a family to be away for three months. A cat-owning islander stated that it is not typical to ask someone to feed your cat during a long absence. Instead, the cat is left to fend for itself by hunting or visiting other homes for food. It would seem likely that at least some of these "abandoned" cats would become semi-feral or completely feral.

Discussion

Descendants from the "Bounty Cats"

Although we know of no evidence that shows that a genetic line of original cats from the *Bounty* survived until 1997, there is a reasonable possibility that at least one did so. The historical record provides convincing evidence that cats arrived on the *Bounty*. With the exception of the near eradication of cats reported by J. Moerenhout in the time of John Adams, there is no record of any other concerted effort to completely eliminate feral cats on Pitcairn until the eradication of 1997. Without any prior well-organized eradication strategy such as that implemented by WMIL, and with the abundant prey available for feral cats such as rats and birds, there is no identifiable reason for an original line of cats to have died out prior to 1997. Thus it is not impossible that the Pitcairn Islanders are correct in their belief that an early line of cats, with a reasonable probability of having originated from the *Bounty*, was lost during the eradication.

Of course the question of whether certain cats on Pitcairn in 1997 were directly descended from cats of the *Bounty* or other early ships probably can never be answered, and probably is irrelevant. The key point is that a number of islanders believe that there were Bounty Cats present on Pitcairn in 1997, and that the eradication led to their extinction on the island.

One other possibility remains: some of the Bounty Cats might have been removed from Pitcairn years ago and continued the genetic line in another location, in the same way that the mutineers' descendants spread to Norfolk Island, New Zealand, and many other locations. For example, the cat that the islanders gave to Captain Charles E. Barker of the U.S.S. *Abardena* in 1889 (probably a male because of its yellow color), might have reproduced and continued its genetic line in some other part of the world. Thus, there is some possibility that there is today a population with a genetic component from the original 1790 cat(s), but in the absence of more information this remains speculative.

Finally, in principle, the original *Bounty* mutineers might have buried a cat that died of disease or age. If so, in principle a DNA line originating from the Bounty Cats could be tracked forward in time. We are, of course, not optimistic about actually locating the remains of an original Bounty cat, but it is an intriguing idea. Interestingly, the partial skull of a cat was discovered on Pitcairn during an archeological excavation (Erskine, 2004, pp 107-108). However, it was not known if the skull dated from the targeted study period of 1790-1856, or from a later date.

Population dynamics

It is tempting to believe that the cat population on Pitcairn is related linearly to the human population. While it is true that larger human populations support larger numbers of cats, a linear model is almost certainly too simple and likely numerically wrong. It is very likely that several factors contribute to the dynamics of the cat populations and that some of these factors may operate nonlinearly. Possible dynamical factors include availability of prey, importation of cats to the island, exceptional care for some (or all) cats by specific individuals, adoption of laws and rules related to the cats, diseases either in cats or prey, neglect by humans, and migration of humans to and from the island. These factors make the dynamics complicated and nonlinear.

We believe that the cat population on Pitcairn has been significantly perturbed by humans numerous times. Initially (ca. 1790) cats were introduced to the island. We assume that upon introduction, most cats remained near habitations and were adopted as pets by some percentage of islanders, and less socialized cats distanced themselves from habitations and eventually established feral colonies. Without a perceptible transition, the following sequence of events probably took place:

1. The cats fed on rats and birds, and the cat population increased.
2. The rats and birds became exhausted, and the cats began to feed on chickens.
3. To prevent loss of chickens, the islanders began killing the cats.
4. With the cat population diminished, the rat population surged as they began to eat crops (fruit, vegetables, sugar cane).
5. In order to control the rat population, the islanders passed laws to protect the cats, with large fines specifically directed at families with children who kill cats.

The cycle then repeated itself, with variations. The cat laws were eventually changed to permit a trouble-making cat to be killed, but only if there was proof that the cat had attacked a chicken. Over the years island court recorded many civil complaints related to animals. Cat laws continued to be updated. At times Islanders reported being plagued by rats. Around 1878 cats were killing chickens and young ducks. In 1940 the island was again overrun with rats. In 1962 cats were attacking chickens and "trigger happy" youths were hunting cats to such an extent that a resident had to entreat the boys not to shoot his cat. The 1997 rat/cat eradication carried the cycle to extremes when the feral cat population presumably was reduced to zero, many pet cats died, and rats returned in huge numbers. Eventually new cats were brought to the island to control the rats.

The pet cat population is more stable than the feral population. During times when feral cats are hunted some people try to protect their pet cats, as an islander did in 1962. Protection of pet cats was also attempted in 1997 during the eradication, but was mostly unsuccessful due to secondary poisoning. Overall, the pet cat population remains relatively stable and changes slowly with the human population except during extreme events (such as the 1997 eradication), but the feral cat population experiences larger and more frequent changes.

A simple qualitative model is the following:

- The cat population reaches equilibrium at about 3 cats (both pet and feral) for 2 people (see below).

- Perturbations of the cat population are human immigration and emigration, episodic hunting/extermination of feral cats, and creation or modification of regulations concerning cats and other animals.

These factors tend to reduce the amount of fluctuations in the cat population compared to humans.

A model and sample calculations of the cat/rat populations over the history of Pitcairn Island are presented in **Appendix 3**.

Equilibrium populations

It is sensible to consider whether the cat populations are, in some sense, in equilibrium. One way to define equilibrium would be the number of cats required for the rat population to be constant. The equilibrium populations consist of both pet and feral cats, since both groups prey on rats. Regardless of the human population, whenever cats exceed the equilibrium number, the rat population falls and the feral cats eventually begin to prey on chickens, resulting in some of the feral cats being culled by the islanders. When cats are fewer than the equilibrium number, rat damage to crops increases, resulting in protection for feral cats and possibly even importation of additional cats. Thus, there is a simple way to determine whether the cats are in equilibrium with the rats:

1. Cats attacking chickens means there are too many cats;
2. Rats destroying crops means there are too few cats.

During periods when the islanders have few complaints about cats or rats, equilibrium may exist. That appeared to be the case in mid-2018 because residents made no negative comments about either cats or rats being a nuisance, and we did not see populations of cats or rats that seemed excessive. We witnessed a pet cat killing a rat, but that would be expected when the populations are stable. We propose that with a human population of 40-50 people, a population of around 60-80 pet and feral cats (roughly 3 cats/2 people) is sufficient for equilibrium on Pitcairn Island. On the other hand, the historical record suggests that equilibrium is rarely achieved for long periods.

Managing the cat populations

Pitcairn does not have a veterinarian. Cats are usually put down when seriously ill if no improvement in their condition comes about naturally. Since a veterinarian is not present to administer euthanasia medication, the cats are usually shot.

Some islanders have learned how to neuter male kittens. When a cat has an unwanted litter, the male kittens may be neutered and allowed to live, but female kittens are more likely to be put down since there is no veterinarian to spay them. For example, in a litter of 5 kittens, only 2 (presumably males) were allowed to live since they could be “de-sexed” by a resident. At times entire litters are killed immediately after birth (Shelling, 2012). In March 2018, Pitcairners Steve Christian and Sue O’Keefe neutered three kittens (“Controlling the Cat Populations,” 2018).

During our field work, some local people were concerned that strangers were asking questions about cats. Our interest in cats might have stirred reminders of the 1997 eradication and perhaps also of the recent survey by the RSPB’s Darwin Project team. We reassured everyone that we did not represent any outside organization and that we were surveying the cats only for our own interest. We discovered that 20 years after the rat and cat eradication, there are still some intense negative feelings about the results. In general there appears to be distrust of any organization that wishes to exert its influence on Pitcairn, particularly if it is a government entity.

The historical record illustrates that islanders have always had their own methods for dealing with imbalances in the cat population. At various times they have hunted the cats, passed laws to protect them, imported them, and given them to passing ships. They value their pet cats, including the semi-feral cats that may give back little affection, but they also neuter males and put down kittens when

needed to control the population. While not based on any overall plan or study, these methods seem to work for the Pitcairn Islanders.

Our experience on Pitcairn leads us to concur with the findings of the recent RSPB Darwin Project report (Kelly, 2016), which states that any future cat eradication or rat eradication (which would impact the cats) must be Pitcairn-community driven and managed, or else it is unlikely to be effective, or even able to be initiated. The community does not want its feral cats to be eradicated until the rats are gone, or for its pet cats to be impacted by secondary poisoning, as occurred in 1997. However, due to the way of life on Pitcairn, there is no practical way for pet cats, including semi-feral cats that live almost exclusively outdoors, to be confined inside for the long period of time that would be required for rodenticide to dissipate from the environment. We are not professionally qualified to state whether or not Pitcairn Island is suitable for another rat and feral cat eradication. However, based on current prevailing attitudes on the island, we question the ability of any outside organization to perform a successful eradication unless it is initiated, planned, and carried out by the Pitcairn community, with the outside organization standing by to offer support. One islander put it this way: “We don’t want people coming here and messing with our cats.”

Plates

Plate 1	Aerial view of Pitcairn Island	Sites at which the trail camera was placed, and the zones defined for statistical analysis of the observations	
Plate 2	General view	**Site 1 (**Adam's Ground**)**	**Zone 1**
Plate 3	General view	**Site 2 (**Big Fence**)**	**Zone 1**
Plate 4	Partial view	**Site 3 (**Flatland**)**	**Zone 6**
Plate 5	View	**Site 4 (**St. Paul's Road**)**	**Zone 2**
Plate 6	Views	**Site 5** (Steve's Garden**)**	**Zone 3**
Plate 7	View	**Site 6 (**Nig's Place**)**	**Zone 6**
Plate 8	Vicinity	**Site 7 (**Tedside, near Sandy Harbor**)**	**Zone 5**
Plate 9	View	**Site 8 (**Bounty Bay**)**	**Zone 2**
Plate 10	View	**Site 9 (**Tennis Court**)**	**Zone 3**
Plate 11	Trail camera images	**Site 1 (**Adam's Ground**)**	**Zone 1**
Plate 12	Trail camera images	**Site 2 (**Big Fence**)**	**Zone 1**
Plate 13	Trail camera images	**Site 3 (**Flatland**)**	**Zone 6**
Plate 14	Trail camera images	**Site 4 (**St. Paul's Road**)**	**Zone 2**
Plate 15	Trail camera images	**Site 5 (**Steve's Garden**)**	**Zone 3**
Plate 16	Trail camera images	**Site 6 (**Nig's Place**)**	**Zone 6**
Plate 17	Trail camera image	**Site 7 (**Tedside, near Sandy Harbor**)**	**Zone 5**
Plate 18	Trail camera images	**Site 8 (**Bounty Bay**)**	**Zone 2**
Plate 19	Trail camera image	**Site 9 (**Tennis Court**)**	**Zone 3**
Plate 20	Pet cats	**Site 2 (**Big Fence**)**	
Plate 21	Pet and semi-feral cats	**Site 3 (**Flatland**)**	
Plate 22	Girls with cats	**Site 3 (**Flatland**)**	

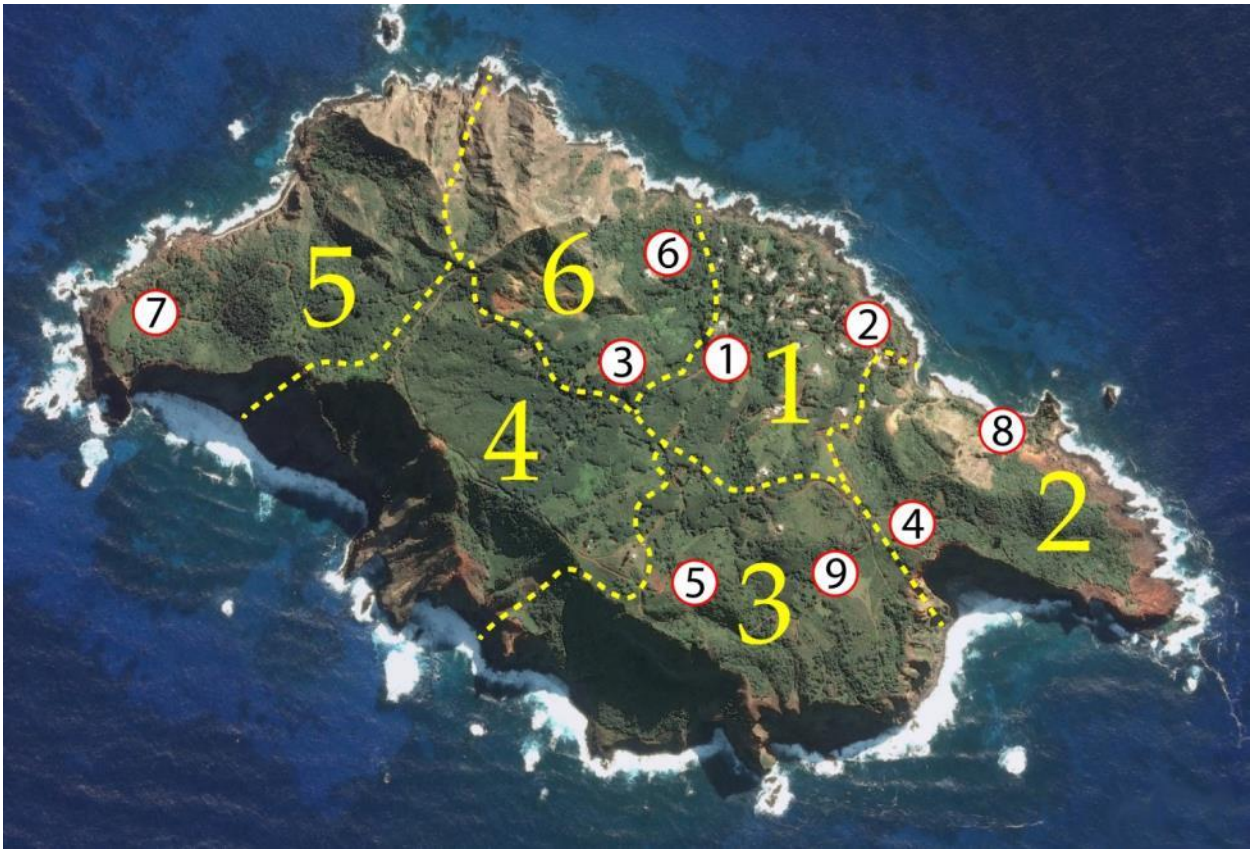


Plate 1 – Aerial view of Pitcairn Island. The nine stations ①②③④⑤⑥⑦⑧⑨ where the trail camera was deployed are shown in their chronological order. The large numbers (123456) indicate the six zones defined in this paper for the statistical analysis of the distributions of the cats. (Source of image: Google Earth)

Plate 2(a,b) – General view of **Site 1** (Adam's Ground). The trail camera was placed off the road just to the right of this photograph. It captured images within an angle of about 40° and at night to a distance of about 10 meters. Daytime pictures are in full color, nighttime pictures are black and white.

Plate 3(a,b) – General view of **Site 2 (**Big Fence). The trail camera was placed beside the driveway, seen in one of the daylight images taken by the trail camera.

Plate 4(a,b) – Partial view of **Site 3** (Flatland), an area of about 1 acre cleared of trees, and the homestead of a family with 9 pet cats. The trail camera was placed in the carport attached to the house.

Plate 5 – View of **Site 4** (St. Paul's Road). The trail camera is oriented toward the bait, which is chunks of cooked fish and kibble. The camera and bait have been artificially illuminated to make them visible in the photograph.

Plate 6(a,b) – Views of **Site 5 (**Steve's Garden). The trail camera was placed next to a shed used to tend the garden.

Plate 7(a,b) – View of **Site 6** (Nig's Place). This house was unoccupied, but a colony of about 4 cats was located there. The trail camera was placed on the wooden deck in the rear of the house. The camera and bait have been artificially illuminated to make them visible in the photograph.

Plate 8(a,b) – Vicinity of **Site 7** (Tedside, near Sandy Harbor). The tortoise enjoyed being fed papaya. The trail camera and bait (artificially illuminated in the lower picture) were set up in a clearing in the dense vegetation.

Plate 9(a,b) – View of the trail camera at **Site 8** (Bounty Bay). The site is located along a rough trail that enters the jungle on the far side of the building (circle). In the lower picture, the camera faces the bait about 1 m away. The camera and bait have been artificially illuminated to make them visible in this photograph.

Plate 10 – View of the trail camera at **Site 9** (Tennis court). The camera was placed off the road in a dense forested area. It faces the bait about 1 m away. The camera and bait have been artificially illuminated to make them visible in this photograph. No cats were photographed during this deployment.

Plate 11 – Four different cats out of five visiting the bait during one night. (**a**) Upper: Cat_1.2; (**b**) Lower: Cat_1.5. (Adam's Ground, **Site 1**)

Plate 11 (con't) – (**c**) Upper: Cat_1.3; (**d**) Lower: Cat_1.4.

Plate 12 – **(a)** Upper: Cat_2.3. A suspected feral cat. **(b)** Lower: Cat_2.1. A known pet cat, "Cocky". (Big Fence, **Site 2**)

Plate 13 – (**a**) Upper: Cat_3.4. A solitary semi–feral cat finding food normally put out by the residents. Cat food is nearly always present on the porch of this home. (**b**) Lower: Defensive behavior among a group of pet and feral cats. Fifteen distinct cats were photographed at this location, some of which were unknown to the residents. This photo is cropped; in the original we can discern 7 different cats. (Flatland, **Site 3**)

Plate 13 (con't) – (**c**) Upper: Cat_3.1 (**d**) Lower: Cat_3.6

Plate 14 – Nighttime visit of a feral cat to the bait, and an unusual daytime photo (in the rain) of a cat among fallen pandanus leaves. The lower picture was taken 1 minute before the camera was retrieved. The approach of the person dispersed the cats. (**a**) Upper: Cat_4.2; (**b**) Lower: Cat_4.3. (St. Paul's Road, **Site 4**)

Plate 15 – Two views of the same feral cat. Upper and lower: Cat_5.1. (Steve's Garden, **Site 5**)

Plate 16 – (**a**) Upper: A suspected feral cat Cat_6.3. (**b**) Lower: Another suspected feral cat Cat_6.1, with a piece of fish bait. (Nig's Place, **Site 6)**

Plate 16(con't) - **(c)** Upper: A (likely) feral kitten, Cat 6.4 ("Mew"). This is the same kitten as seen in the Frontispiece of this report. (**d**) Lower: "Semi-feral chickens" in the daytime, perhaps evidence that the local cats currently do not prey on the chickens. (Nig's Place, **Site 6)**

Plate 17 – The only picture of a particular feral cat (Cat_7.1) at extreme western tip of Pitcairn Island. There were anecdotal reports of a cat that fits this appearance, so this one may have been sighted by residents. Unfortunately no additional images or sightings were obtained. (Tedside, **Site 7**)

Plate 18 – Visits to the bait by different feral cats (**a**) Upper: Cat_8.1; (**b**) Lower: Cat_8.2. (Bounty Bay, **Site 8**)

Plate 19 – No cats were photographed at this site. (Tennis Court, **Site 9**)

Plate 20 – (**a**) Upper: Pet cats “Sparkle” (Cat_2.4) and “Hopper” (Cat_2.5). The cats play and eat together. (**b**) Lower: Sparkle with a rat (*Rattus exulans*). (Big Fence, **Site 2**)

Plate 21 – Three individuals from a group of about 15 pets and semi-feral cats. (**a**) Upper: "Dirty Butt" (Cat_3.15); (**b**) Middle: "Bullet" (Cat_3.2); (**c**) Lower: Cat_3.6. (Flatland, **Site 3**)

Plate 22 – Young Pitcairn girls interact with their pet cats. Cats are valued for many of the island's residents, especially children. (**a**) Upper: "Dirty Butt" (Cat_3.15); (**b**) Lower: "Bullet" (Cat_3.2). (Flatland, **Site 3**)

Appendices

Appendix 1 – Cats observed in 2018

Location Name PIC_XXXX		Location Name PIC_XXXX	
Adam's Ground (**Site 1**) Cat_1.1 PIC_0161		Big Fence (**Site 2**) Cat_2.1 "**Cocky**" PIC_0211	
Cat_1.2 PIC_0165		Cat_2.2 **"Rafiki"** PIC_0976	
Cat_1.3 PIC_0167		Cat_2.3 PIC_0217	
Cat_1.4 PIC_0174		Cat_2.4 **"Sparkle"** PIC_0772	
Cat_1.5 PIC_0168		Cat_2.5 **"Hopper"** PIC_0787	

Flatland
(**Site 3**)

Cat_3.1
"Raccoon"
"Coonie"

PIC_0273

Cat_3.2
"Bullet"

PIC_0422

Cat_3.3

PIC_0306

Cat_3.4

PIC_0404

Cat_3.5

PIC_0316

Flatland
(**Site 3**)

Cat_3.6

PIC_0545

Cat_3.7

PIC_0416

Cat_3.8

PIC_0302

Cat_3.9

PIC_0425

Cat_3.10

PIC_0525

Flatland (**Site 3**)

Cat_3.11

PIC_0455

Cat_3.12

PIC_0337

Cat_3.13

PIC_0312

Cat_3.14

PIC_0405

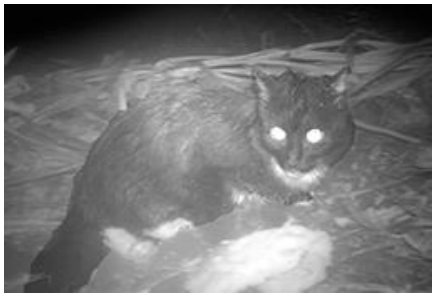
3.15 **"Dirty Butt" "DB"**

PIC_0379

St. Paul's Road (**Site 4**)

Cat_4.1

PIC_0564



Cat_4.2

PIC_0552

Cat_4.3

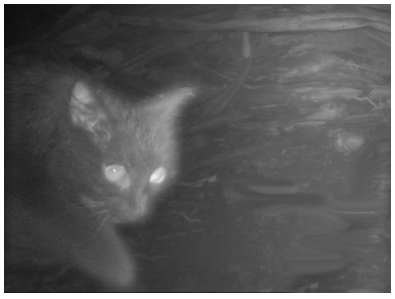
PIC_0605

Cat_4.4

PIC_0591

Cat_4.5

PIC_0569



Steve's Garden (**Site 5**)

Cat_5.1

PIC_0627

Tedside (**Site 7**)

Cat_7.1

PIC_0723

Nig's Place (**Site 6**)

Cat_6.1

PIC_0635

Cat_6.2

PIC_0650

Cat_6.3

PIC_0669

Cat_6.4 **"Mew"**

PIC_0687

Bounty Bay Cave (**Site 8**)

Cat_8.1

PIC_0728

Cat_8.2

PIC_0730

Cat_9.1

…

No cats were photographed by the trail camera at Site 9. We leave this category available for potential future revision.

PIC_XXXX This number refers to the photograph number in our full archive taken in 2018.

Appendix 2 – Additional cats, not seen or photographed in 2018

Residence **c**	Cat_10.1	
Residence **d**	Cat_10.2	
Residence **e**	Cat_10.3 Cat_10.4	
Residence **f**	Cat_10.5	
Residence **g**	Cat_10.6	
Residence **h**	Cat_10.7	
Residence **i**	Cat_10.8 Cat_10.9 Cat_10.10	
Residence **j**	Cat_10.11 **"Duffus"**	
Tedside (near Site 7)	Cat_10.12	
Tedside (near Adamstown)	Cat_10.13	
Adamstown (near shop)	Cat_10.14	
Steve's Garden	Cat_10.15 Cat_10.16 Cat_10.17	
Hill of Difficulty	Cat_10.18	

Note: We made visits to Residence **a** and Residence **b.** Photographs of cats in those locations are included in Appendix 1.

Appendix 3 – Model population dynamics

In spite of the extremely limited information about the populations of cats on Pitcairn Island, we have made an attempt to describe the variation in the cat population over time. We do this by adopting a reasonable dynamical model and enforcing certain constraints that we infer from the historical records.

Model assumptions

In order to constrain the model (and guide its development) we make the following assumptions, which we believe are justified for Pitcairn Island:

1. **The human population** on the island over the 230 years of its history since 1790 is quite well-documented. We will assume that it is determined exclusively by human actions (births, migration, deaths), and we will model it with an explicit function of time. The number of humans will not depend on the number of cats and/or rats.

2. **The cats** were (and are) supported by the human population, together with predation on rats. Thus, the number of cats depends on the number of humans and the number of rats. The cat population on the island had three significant events, driven by the humans: (1) the arrival of cats on the *Bounty*; (2) A partial culling around 1820, motivated by the cats preying on chickens; and (3) A major eradication (together with the rats) in 1997 that nearly (but not completely) eliminated both the cats and the rats.

3. **The rats** were already established on the island when the *Bounty* arrived. It is likely that the population of rats increased because of the presence of the humans, but was also kept in check by a growing population of cats. The interaction between cats and rats (predation) is represented by an increase in the cat population and a corresponding decrease in the rat population. In fact, the initial number of rats isn't very important in the simulations.

4. **The three populations** {humans, cats, rats} will be represented by single numbers. Thus, we will not distinguish different categories of humans (male, female, young, old, etc.), cats (pets, semi-feral, feral, etc.), or rats (species, age, etc.), but rather we will model only the lumped "populations". Similarly, the geography of the island (area, terrain, etc.) does not enter the model, space is not a variable or parameter, the weather, seasonal variations, and movement of humans around the island are not part of the model. No other populations (e.g., chickens, birds, etc.) are tracked.

5. **Specific events**, such as immigration, emigration, and eradication, can be represented as single-time sudden changes of the population. That is, the model will not attempt to follow the dynamic effects of adjusting to the sudden change, but it will follow the populations up to the event and then after the event with a new starting value.

Thus, the model will contain a population of humans that evolves independently of the cats and rats, and populations of cats and rats that interact with the humans and with each other, so the model is of two populations of competitive species.

Model equations

Our model is typical of such models that have been used historically (Murray, 1993), but the processes and parameter values will be specific to Pitcairn Island. We define the three populations as functions of time: x_1[t]=humans, x_2[t]=cats, x_3[t]=rats. The function $x_1[t]$ is available from the historical record (see below). The dynamical equations for the cats and rats are:

$$\left.\begin{aligned} \frac{dx_2}{dt} &= A_2 x_2[t]\left[1-\frac{x_2[t]}{w_2[t]}\right] + Bx_2[t]x_3[t] + \sum_{j=1}^{j_{\max}} C_{2j}\delta[t-t_{kj}] \\ x_2[0] &= N_2 \\ \frac{dx_3}{dt} &= A_3 x_3[t]\left[1-\frac{x_3[t]}{w_3[t]}\right] - Bx_3[t]x_2[t] + \sum_{j=1}^{j_{\max}} C_{3j}\delta[t-t_{kj}] \\ x_3[0] &= N_3 \end{aligned}\right\} \quad (1)$$

where $\delta[t-t_{kj}]$ is the Dirac delta function and A_k, B, C_{kj}, N_k (k=2,3) are constants, and where

$$w_k[t] = \sum_{i=0}^{3} \mathrm{w}_{ki} x_i[t] \quad (2)$$

will be described below.

The physical meanings of the parameters are:

A_k **Rate of increase** of the populations of cats and rats by births, support from humans, etc.

B **Predation** of the rats by the cats. With B >0, the cats gain and the rats lose.

C_{ki} **Sudden jumps** in the populations. The Dirac delta function $\delta[t-t_{kj}]$ in the differential equations causes discontinuous jumps in the populations enabling us to account for immigration ($C_{ki}>0$) and emigration ($C_{ki}<0$), as well as local events (e.g., eradication, catastrophic disease, etc.) that suddenly modify the populations.

N_k **Initial populations**. These are the numbers of cats and rats present immediately after the arrival of the *Bounty*. The model does not distinguish between, say, rats arriving with the ship from rats already present on the island. We know that N_1, the initial number of humans from the *Bounty*, is 27, and we can reasonably speculate that N_2, the initial number of cats, is "a few", say 4. It might be anyone's guess for the initial number of rats N_3, so it will be considered a relative number.

$w_k[t]$ **Carrying capacity**.This quantity is the number of individuals which the population k approaches at large time, in the absence of any other interactions. In typical simulations (e.g., Murray, 1993, p. 63), $w_k[t]$ is a fixed number, leading to the population growth as an "**S**" shaped curve called "logistic." However, in the present case we have chosen to make $w_k[t]$ a dynamical quantity. For

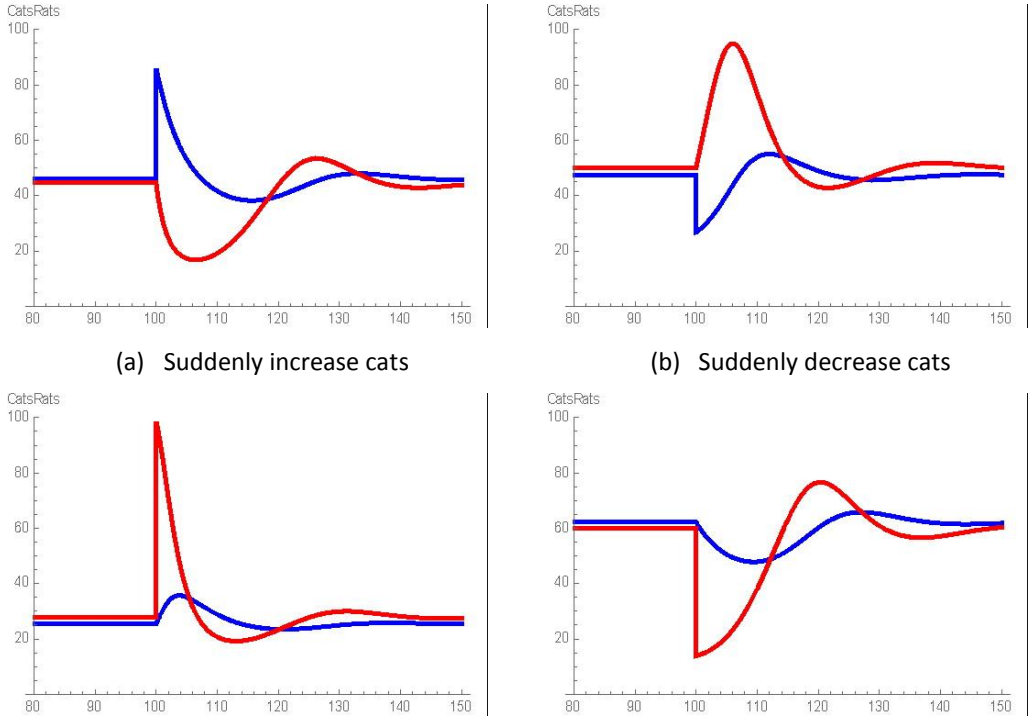
instance, the carrying capacity for cats should depend on the human population $x_1[t]$ and the rat population $x_3[t]$, hence we could include these by writing $w_2[t] = w_{20} + w_{21}x_1[t] + w_{23}x_3[t]$, where w_{20}, w_{21}, w_{23} are constants. This expression provides a mechanism for the populations to interact other than directly by predation. Thus, while the cats increase by direct predation on the rats, they also increase by the indirect effect of having more humans to feed them and care for them.

We use *Mathematica* to numerically solve the dynamical equations for the populations. Solutions to these equations will represent the populations as a function of time.

Model 1 – Constant human population

In order to demonstrate the basic dynamics of the cat/rat interaction, we first assume the human population is constant $x_1[t] \equiv N_1$ and the carrying capacities are constants: $w_2[t] = w_{20}$, $w_3[t] = w_{30}$ Also, we specify the initial cats and rats as $x_2[0] = N_2$ and $x_3[0] = N_3$, which are arbitrary. This basis model enables us to observe the consequences of sudden changes in the cat and rat populations (using the Dirac Delta functions), and of predation.

Figure A1 shows the effects of four typical sudden jumps in the cats and in the rats. It is clear that changes in the rat population produce correlated changes in the cat population, but changes in the cat populations produce anti-correlated changes in the rat population.



(a) Suddenly increase cats

(b) Suddenly decrease cats

(c) Suddenly increase rats

(d) Suddenly decrease rats

Figure A1 – Four cases of cat-rat interactions at constant human population. Blue=cats, Red=rats. The human population in all four plots is the same constant value, which is immaterial. The time scale is arbitrary.

Model 2 – Historically correct human population on Pitcairn

We now introduce the historically correct human population, which includes sudden changes due to immigration and emigration. **Figure A2** shows the historical record of the human population on Pitcairn Island (See references top of figure).

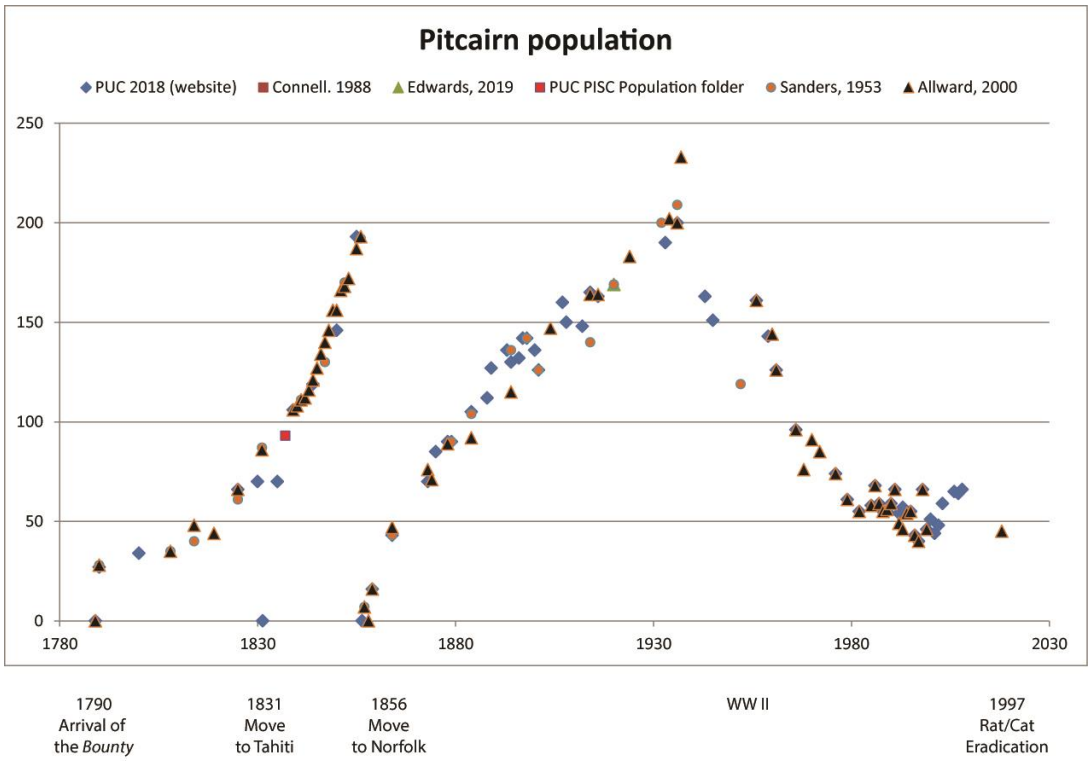


Figure A2 – Historical record of the human population of Pitcairn Island

The function in this figure has four large discontinuous jumps:

1790 Arrival of the *Bounty* (+27 people)
1831 Entire population moved to Tahiti, returned after few months (-64, +60 people)
1856 Entire population moved to Norfolk. Partial return over next 10 years (-194 people)

We represent the historical record with a smooth function that includes these discontinuous jumps. To these events, we will add two more discontinuous events:

1820 (Partial) eradication of cats due to their predation on chickens
1997 (Nearly) total eradication of cats and rats

We assume the following functions for the carrying capacities:

$$\left.\begin{aligned} \boldsymbol{w}_2[\boldsymbol{t}] &= 10 + 0.3\boldsymbol{x}_1[\boldsymbol{t}] \\ \boldsymbol{w}_3[\boldsymbol{t}] &= 500 + 10\boldsymbol{x}_1[\boldsymbol{t}] \end{aligned}\right\} \tag{3}$$

Finally, we solve the dynamical equations (2,3) for the cat and rat populations, using reasonable values for the other parameters. **Figure A3** shows one such simulation, running over the 250 years from 1790 to 2040; it is typical of simulations we find with various values of the parameters.

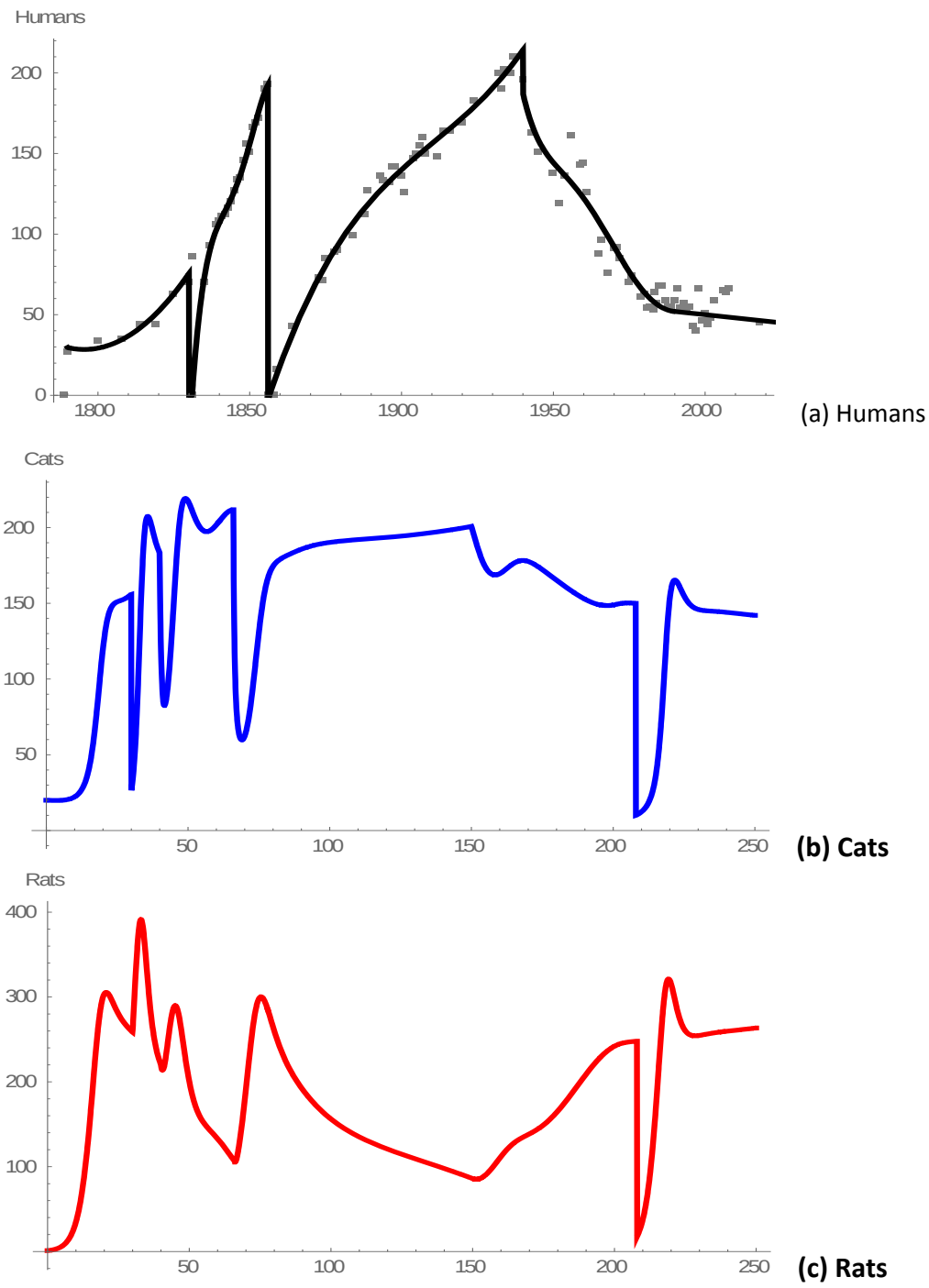


Figure A3 – Model simulations of the populations of Pitcairn Island. (a) Humans (from **Figure A2**); (b) Cats); (c) Rats. These simulations include the major events listed above, including the human migrations (1831, 1856), the cat culling (1820), and the cat/rat eradication (1997).

The simulation in **Figure A3** shows that when the cats were culled around 1820, the rat population increased significantly. When the humans left the island in 1831 and 1856 the cat population dropped, and the rat population again surged. In 1997, when there was a general (and almost total) eradication of both cats and rats, both populations were driven to almost zero; the rats recovered much more quickly than the cats. In fact, the islanders had to import cats to deal with the rat population explosion.

Varying the parameters (e.g., the growth rates of cats and rats (A_k), strength of predation (B), and (very importantly) the direct support of cats and rats by the human population ($w_k[t]$), we obtain some variation in the population functions. Somewhat to our surprise, we find a rather narrow ranges of the parameters for which stable simulations are obtained. The simulations do display the basic effects of the cat/rat populations: When the cats go up, the rats go down (and vice versa). When the humans leave the island, both the cats and the rats decline abruptly. And incomplete eradication doesn't last long.

Comments on the simulations

The models examined in this study are quite typical of models often used for competing populations (Murray, 1993). For instance, they have been used in attempts to account for the response to invasive species such as the cane toad, the zebra mussel, and to the introduction of Nile Perch into Lake Victoria. They are also used to model highly nonlinear systems such as the periodic emergence of locusts. As such, the important caveats and warnings provided by Murray (p. 88) are appropriate here. Murray warns that even if the model simulations seem to agree with the observational data, that does not necessarily imply that the model is correct. The basic reason for this weakness is that simulations with many parameters almost always can be made to fit noisy, incomplete, or incorrect field data. It is an almost irresistible temptation to simply add more parameters to a model until acceptable agreement is reached, but this can be a trap. The lesson here is: Given agreement between the history and the model, models with fewer parameters are likely to be closer to physical reality. In the present case {humans, cats, rats}, we found some evidence that this danger lurks nearby. As we varied the parameters in the equations, it was rather easy to produce unstable behavior, e.g., premature extinction or runaway increasing populations. Most often, the effect was extinction of the rats and corresponding instability of the cat populations. The cure was to back off and stay with parameters that produced finite, even reasonable, behavior. The best sets of parameters values, and therefore which behaviors, cannot easily be chosen.

Mathematically, the instability effects are due to the fact that the dynamic equations are "stiff" (various terms have widely differing values). To some extent this problem can be ameliorated by recasting the equations in dimensionless form and imposing constraints derived from the field observations. We have not done this (yet), hence the results presented above should be regarded as qualitative, and perhaps some of the behaviors we see in the simulations are simply wrong for Pitcairn Island. After all, this model involved lumped populations: it does not resolve age, sex, geography, weather, other species, etc.

However, in defense of the simulations, numerous features consistently emerge that are reasonable and that satisfy common sense. Thus, the mirroring of the cat/rat populations via predation (more

cats→fewer rats, more rats→more cats) is surely correct. Also, the support of both cats and rats by humans undoubtedly is responsible for tracking of both animals with the human population.

Among the many questions these simulations raise, the following are significant: For Pitcairn Island, did the cat/rat populations smooth out the violent swings in the human population? What would be the effect of the humans changing from 1 cat/human to 2 cats/human? Do the populations actually "ring"? Can any reasonable number of cats cause complete eradication of the rats?

Because the cat/rat populations on Pitcairn Island are locked with the human population, the future of the cat/rat populations might be inferred by simulations such as we have presented here, but effort should be made to determine better values of the model parameters, and the model should be expanded to include more species (chickens, birds, categories of cats, etc.) and more processes (geography, weather, disease, sterilization, etc.). Even with these developments, we believe the simulations will remain qualitative, but, we hope, useful.

Appendix 4 – Stories of pet cats on Pitcairn Island

In 2002 a series of postal stamps was issued to commemorate Pitcairn Island's cats. Pitcairn residents photographed several well-known cats of the island and sent the images to New Zealand artist Nancy Tichborne, who painted images used for the stamps. The names of the cats are "Simba Christian," "Miti Christian," "Nala Brown," and "Alicat Pulau." The "family" name identified the Christian and Brown families and "Alicat Pulau" lived at the school located at Pulau just outside Adamstown.

Plate A3 – Stamps and a First Day Cover from Pitcairn Island, featuring cats. The cats were actual living pets.

Several cats have been featured in Pitcairn Island's monthly publication "The Pitcairn Miscellany." The March 1998 issue has the story of "Jazz," a cat that disappeared for 12 days. In the March 2000 edition, a cat named "Archie" was described as a "future safeguard against rats." The March 2017 issue tells of a kitten called "Duffus" becoming trapped behind a freezer.

Appreciations

We sincerely thank our hosts and supporters on Pitcairn Island. Steve and Olive Christian opened their home to us for 11 days and made it possible for us to make our observations. Special thanks also go to Nadine, Adrianna, and Isabel Christian for their hospitality, to Kevin Young for sharing his immense local knowledge, and to all the other Pitcairn Islanders who made us feel like part of the community during our too-short visit.

We express our very sincere appreciation to Neil Broughton and the crew of the *Claymore II* for their significant contributions to this project. We especially thank Andrew Fagan for the loan of his laptop computer in the face of having lost our computer at the airport.

The Pitcairn Island Study Center at Pacific Union College in Angwin, California, provided invaluable information for our history study and welcomed our visits there. In particular, we would like to thank Dr. Herbert Ford and Katharine Van Arsdale of the PUC/PISC for their assistance during the project.

We greatly appreciate the assistance of Mike Bell and Elizabeth (Biz) Bell of Wildlife Management International Limited (WMIL) who provided us with documents and personal communications regarding the 1997 rat and feral cat eradication.

We owe thanks to Leah Honeywood, Research Assistant at the Norfolk Island Museum, and David Ransom, editor of "The *Bounty,*" the magazine of the Pitcairn and Norfolk Islands Society.

We also wish to thank Dr. Mitchell Low of the University of Western Australia for sharing his expertise on Norfolk Island history.

Finally, the authors would like to thank their wives, Kay Schmieder and Debby Lee, for their obsession with cats, expressed by their involvement in rescue groups. We are far on the side of loving and caring for cats rather than working to eradicate them, but in the course of this project became more sensitive to the limits of uncontrolled breeding and the need for rational management programs, especially for islands.

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