

Reducing Homeless Cat Populations on Kauai *Compassionate Approaches are Working Better*

Many people see trapping, removing and killing homeless outdoor cats as a necessary, fast and permanent way to reduce the cat populations, but the real experience on Kauai shows otherwise. An estimated 12,000^{i,ii} homeless cats live in Kauai's towns and neighborhoods. Over the last decade, about 23,000 of these "community" cats have been trapped, removed, and killed.ⁱⁱⁱ And yet, their numbers seem relatively unchanged.

The primary reason for this apparent contradiction is the cat's high reproductive rate. Homeless female cats, living outdoors without optimal nutrition, can produce up to 550 kittens per 100 adult females each year.^{iv, v} After cat removal, population growth rates can be as high as 95%.^{vi} Since this greatly exceeds the 20% annual catch rate, no significant population reduction was ever possible.

While most of the cat removal has been geographically scattered and short-term, some has focused within specific areas for longer time periods. This is more likely to achieve the high removal rates necessary to reduce cat populations significantly. To assess how well these focused removal efforts are working on Kauai, KCCP obtained records of 16 such projects.^{vii} These were conducted over the last 6 years, and trapped about 500 cats.

None of these have permanently removed the cats, and three were intentionally stopped due to exploding rat populations. Total population suppression is estimated at 255 cats,^{viii} or 2.1% of the island total. The most successful projects are in four wildlife areas where continuous trapping is employed: within these areas population suppression is over 90%. For the other areas, it was only 30%. The low rate is due to intermittent trapping and subsequent repopulation from high birth rates and immigration.^{ix}

Since cats' high reproductive rate is the primary factor that is confounding efforts to reduce the population, why not target their reproduction? This is what TNR does.

In the last decade, about 5400 cats have been Trapped-Neutered-Returned^x (TNR'd) on Kauai,^{xi} and these projects have reduced the island-wide population of neighborhood cats by an estimated 2200,^{xii} or 18%. The estimated population suppression from trapping and killing over four times the cats – the 23,000 – is only 11%.^{xiii}

In addition to reducing cat populations, TNR also reduces predation^{xiv, xv, xvi, xvii} and disease^{xviii, xix} for the cats that remain. The total impact mitigation from the combination of population reduction, less predation and reduced disease is much greater than the 18% through population reduction alone. Analysis shows it's up to 30% island-wide.^{xx}

TNR is significantly less expensive than trap and remove,^{xxi} has proven that it can scale island-wide, and is working better! It should be the preferred method to resolve cat population problems within our towns and neighborhoods.

To fully solve the community cat problem we must address its source. Both sides of the debate agree on this. That means available, inexpensive spay/neuter for all. A low kill rate approach like TNR is needed for those who see lethal removal as unacceptable and who won't cooperate if this is the only supported choice.^{xxii}

References and Notes

- ⁱ Feral Cat Task Force Final Report, from Accord3.0 Website, <http://www.accord3.com/pg79.cfm>, estimate is 15,000 to 20,000 in wild and populated areas combined.
- ⁱⁱ Scott, Kauai's Feral Cats, The Scope of the Problem, 2013. This is source of the Feral Cat Task Force estimate, and it shows that about 75% live in populated areas. Available on request.
- ⁱⁱⁱ From Kauai Humane Society statistics, FOIA information from US Fish and Wildlife, and UIPA information from Hawaii's Dept. of Land and Natural Resources. See Appendix 2.
- ^{iv} Nutter, Evaluation of a Trap-Neuter-Return Management Program for Feral Cat Colonies: Population Dynamics, Home Ranges, and Potentially Zoonotic Diseases, NCSU Comparative Biomedical Science, 2005. The author reports on a sample of over 2000 cats.
- ^v Schmidt et. al., Survival, Fecundity, and Movement of Free-Roaming Cats, *Journal of Wildlife Management* 71(3):915-919; 2007)
- ^{vi} Appendix 1, calculation 1
- ^{vii} KCCP obtained information from State and Federal agencies via information requests. KCCP itself removed certain cats (non-lethally). Records from 19 projects were obtained, but long-term results are not known for 3 of these. See Appendix 2.
- ^{viii} Appendix 1, calculation 2
- ^{ix} Miller et. al., Simulating Free-Roaming Cat Population Management Options in Open Demographic Environments, *PlosOne*, 2014
- ^x TNR (Trap-Neuter-Return) captures fertile cats, surgically sterilizes them, returns them to their outdoor home, and then manages the cats to reduce their population over time.
- ^{xi} Estimates from KCCP data (2007 – present) and Kauai Humane information, see Appendix 3
- ^{xii} See Appendix 3.
- ^{xiii} See Appendix 1, Calculation 2.
- ^{xiv} TNR Fact Sheet 2, Predation, http://voxfelina.com/voxfelina/Vox_Felina_Fact_Sheet_Predation_v_1.1.pdf
- ^{xv} Loyd et. al. Quantifying free-roaming domestic cat predation using animal-borne video cameras, 2013
- ^{xvi} Silva-Rodríguez, E.A. and Sieving, K.E., "Influence of Care of Domestic Carnivores on Their Predation on Vertebrates." *Conservation Biology* 2012. 25(4): p. 808-815.
- ^{xvii} From FOIA, US Fish and Wildlife field notes, 20140114 Email Marie McKenzie to Kim Uyehara_Botulism DB.pdf
- ^{xviii} Nutter, Evaluation of a Trap-Neuter-Return Management Program for Feral Cat Colonies: Population Dynamics, Home Ranges, and Potentially Zoonotic Diseases, NCSU Comparative Biomedical Science, 2005
- ^{xix} VanWormer, *Toxoplasma gondii*, Source to Sea: Higher Contribution of Domestic Felids to Terrestrial Parasite Loading Despite Lower Infection Prevalence *EcoHealth*, September 2013
- ^{xx} Appendix 3
- ^{xxi} Zawistowski et. al., Simulating different approaches for managing free-roaming cat populations, ACC&D, 2011
- ^{xxii} On Kauai, animal abandonment rates tripled in some areas after high kill rates for cats at the Kauai Humane Society became highly publicized in mid-2013. Requests for no-kill service from KCCP have tripled since then as well.

Appendix 1: Calculations

Calculation 1: Cat Reproductive Rate

All estimates are from mainland studies, and many feel that birth and survival rates would be higher on Hawaii due to full-year breeding seasons and richer environmental resources.

	Nutter North Carolina	Schmidt et. al. Texas
Birth Rate	4.2 (median)	5.6 (mean)
Kitten Survival	50% (3 months), 25% (6 months) *Est. annual: 17%	50% (3 months, feral) 75% (3 months, semi) Est. Annual: 30%, 20%
Population ratio M/F	33%/67%	Not given
Adult survival M/F	0.40 / 0.60	0.57 / 0.88
Total Birth rate	50% or 0.5	80% to 120% or 0.8 to 1.2
Population growth rate, r	3% or 0.03	60% to 95% or 0.6 to 0.95

*Nutter presents a Kaplan-Meier analysis indicating that after 125 days, kitten death rates approach those of adults. Accordingly, annual death rates are calculated by:

$$6 \text{ month survival} \times \sqrt{\text{adult annual survival}} = \text{kitten annual survival}$$

Nutter's death rate of 47% is very close to the birth rate, so this represents a stable population, as one would find in a "full" biological environment.

Schmidt's data suggests that higher values are possible when food is plentiful. This value is used in analysis below (Calculation 2) for maximal rates when cats are removed from an area.ⁱ These birth rate values greatly exceed the death rate, so that the population growth rate is quite high.

Multiple authors report lower numbers as well, with birth rates as low as 40% of Nutter's. These suggest negative population growth rates (contraction) when populations are too high, i.e. above the environment's carrying capacity.

We believe this analysis is conservative for Hawaii. Lohr postulated birth rates of 0.75 for Hawaii under normal situations.ⁱⁱ This would suggest population growth rates, r, of 0.55, just under Schmidt's lower value. This higher value supports the assertion by many that birth and population growth rates will be higher in Hawaii due to its warm climate.

Calculation 2: Island-wide impact mitigation from Trap and Remove

Details for the population suppression resulting from removal of the 23,000 cats in the last decade are presented below. Some of the trapping was focused, for example, local hotels that trap cats on their property. Most of the trapping was not focused, e.g. residence obtained a trap from KHS, trapped one or two cats on their property, and returned the trap.ⁱⁱⁱ

Known Focused Trapping at 16 locations

The island-wide neighborhood cat mitigation from known focused trap and remove can be determined from the tables in Appendix 2. Some of this trapping was in wildlife areas adjacent to but not within neighborhoods. Nonetheless, all the cats are included. Total cat suppression is estimated as 255 of the original population. This is a 2.1% reduction of the island-wide total of 12,000 neighborhood cats. This trapping was performed on an estimated original population of 480 cats, or 4% of the island-wide total.

Trapping for 22,500 Cats: Casual, Intermittent Focused, and Continuous Focused

The results from Appendix 2 are used as a model. An estimated 20% of the trapping is focused in one area.^{iv}

	Focused, Continuous	Focused, Intermittent	Casual
Percentage of trapping	5%	15%	80%
Population suppression	80%	20%	10%*
Total, Island-wide	4%	3%	8%

*The justification for the 10% value is shown in calculation 3.

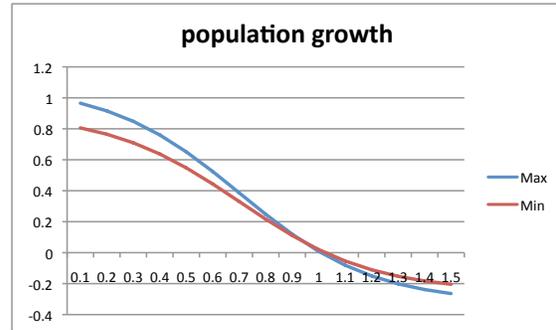
Total population suppression is 15% of cats from the entire population less cats in the known focused trapping or under TNR management. Thus, total cat suppression is:

$$15\% \times (100\% - 4\% - 34\%) = 9.3\% \text{ or } 1120 \text{ cats}$$

$$\text{Combined total: } 9.3\% + 2.1\% = 11.4\% \text{ or } 1375 \text{ cats}$$

Calculation 3: Casual Trapping Metrics

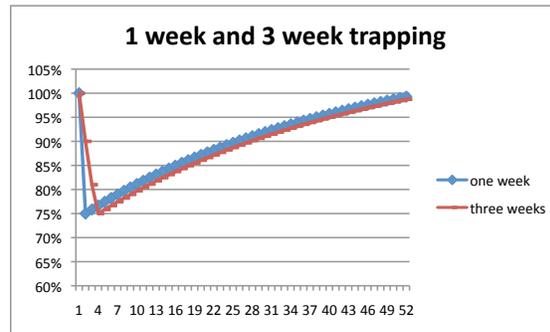
The estimated effect of casual trapping is based on a growth rate analysis. Two logistic growth curves are shown in the graph at the right, based on values from Schimdt et. al., which was referenced in calculation1 above. The values establish a range for maximum values of the logistic function, which occurs for very low population levels. The value at a 100% population level (biological carrying capacity) is very near zero.



The number of animals trapped annually in casual trapping is 80% of 22,500/10 or 1800. This is 25% of the of the total cat population of 7000 that is being casually trapped.v

At a population level of 75%, the growth rate (27% to 31%) exceeds the removal rate. Immigration, while modest, adds more. Simplistically, this means there is a zero population reduction. This is not what actually happens. In a real situation, there is a time lag between cat removal and cat rebound. The length of time between removal and rebound back to a 100% population level determines the average number of cats and thus the degree of cat suppression.

Two examples are shown in the graph. One traps 25% in 1 week. This might correspond to removing one cat from a small neighborhood population. The second traps 5 cats in 3 weeks. This might correspond to removing 5 cats from a condominium area. Each shows a resulting annual average cat population of approximately 90%. Thus, the cat suppression from ongoing casual trapping is approximately 10%. In both cases, the permanent suppression is zero, i.e. the cat population returns to 100% after about one year.



Population rebound within one year is very typical on Kauai, so both examples are realistic.

References

ⁱ Maximum population growth rates, r , are assumed when 80% of cats are removed; for lesser removal percentages, the maximal rate is linearly prorated to lower values.

ⁱⁱ Lohr, C. et. al, Costs and benefits of trap-neuter-release and euthanasia for removal of urban cats in Oahu, Hawaii, *Conserv Biol.* 2013 Feb;27(1):64-73. doi: 10.1111/j.1523-1739.2012.01935.x. Epub 2012 Sep 25.

ⁱⁱⁱ KCCP requested data from KHS to determine how much focused trapping versus scattered trapping has been performed in the last 6 years, but KHS declined to provide the information.

^{iv} Apparent continuous trapping is between 5% and 10% based on anecdotal observations in the KHS lobby (random sampling). Here the assumed 20% is quite high and thus conservative.

^v 12,000 - 440 (16 known trapping areas) - 620 (focused trapping) - 4080 (TNR) \approx 7000

Appendix 2: Trap and Remove Activities Analyzed on Kauai

	Location	Date	Event	Outcome	# rem	base #	Source	remain	Comment
1	Salt Pond 1	mid-2012	30 cats removed	cats back by mid-2013	30	40	ACO/KHS	100%	
2	Salt Pond2a	late 2014 - mid 2015	2 TNR colonies removed (17) plus additional 20 (estimated)	cats back by late 2016	37	40	ACO	100%	near complete removal
unk	Salt Pond 2b	late 2014 - mid 2015	total of 70 cats removed by ACO, but some were from park	one time trapping; estimated return rate to wild area is 0.1	50	55	ACO	25%	% remain estimated from immigration rate = 0.1
3	HNWR	2010 - 2015	continuous trapping	cats continuously present but at very low levels	130	90	USFWS	5%	base numbers are projected from immigration rates of .25, .25, .05 and 0.8 growth rate
4	KNWR		intermittent trapping		70	50	USFWS	5%	
5	HNWR		intermittant trapping		15	10	USFWS	10%	
n/a	mahalepu	2013	58 cats removed from wild areas and near GC	unknown **this is mostly a wild area and is excluded	58		DLNR	excluded	
6	Kukuiula	mid-2015	cats removed	all cats returned in ~1 year	12	15	KCCP	100%	cats now in a rescue
7	Larsen's beach	mid-2015	10 colony cats plus unknown other cats	subset of cats back in 4 months **wild area abuts farms and illegal camping areas	20	25	KCCP	70%	based on reports from illegal campers
8	Small boat harbor	late 2015 - early 2016	colony of 25-30 apparently removed	cats gone for several months, but a large populatio is back in 6 months	25	30	KCCP & ACO	100%	virtually no effect
9	Waimea PC	late 2015 - early 2016	~ 10 cats removed from one area, but other cats present on the property	cats continue to be present with no reported bird issues	10	12	KCCP	50%	

	Location	Date	Event	Outcome	# rem	base #	Source	% remain	Comment
10	Coffee fields	10 & 11 2014	trapping near bird colonies	11 cats trapped, but assess that cats are still present	11	15	DLNR	100%	due to non-continuous
11	Kaumakani	Oct 2014 - Jan 2015	trapping near bird colonies	4 cats; OK for several months; but trapping stopped	4	4	DLNR	100%	due to non-continuous
	Private trapping, Albatross	2014	30 cats removed	unknown **excluded; too little is known	30		COK UIPA	excluded	
12	Princeville SC	2012	12-15 cats removed	large number of rats; 5+3 cats brought back	15	15	KCCP	50%	
13	Regency Resort	2016	maintained colony removed	rat invasion; unk number of cats brought in	12	12	KCCP	50%	estimated # cats returned based on volunteer information
14	PMRF base	2013	cats on base removed	rats eating signal cables; allowed TNR on base	30	35	KCCP	50%	
15	PMRF wetlands	2013-2105	cats removed around wetland restoration	ongoing cat removal; no reports of predation problems	50	25	DLNR	10%	DLNR data
16	Lagoons GC	ongoing	cats removed in nesting season	~10 cats removed annually	30	10	DLNR	50%	ongoing with 6 months on, 6 months off

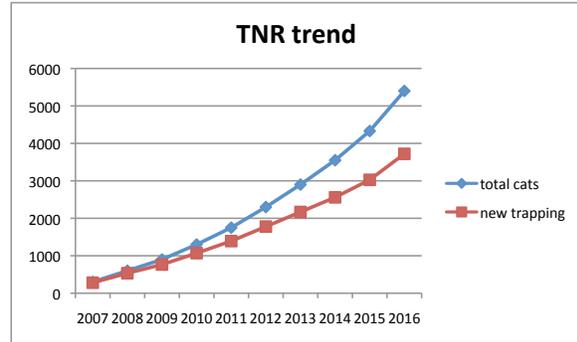
Summary:

reduction in 4 continuous areas	93%
reduction in 5 intermittent areas	31%
reduction in 7 one time areas	29%
total original cat population (est.)	483
cats removed (est.)	255
percentage removed	53%

Appendix 3: TNR Conducted over the Last 10 Years

About 5400 cats were trapped for TNR over the last decade. Data is from KCCP, KHS and members of the community who practice TNR independently. The KHS data is used to estimate TNR spay and neuter done by volunteers not associated with KCCP.

Many of the cats trapped are within areas where 100% of cats have already been spayed or neutered, but new cats have immigrated in. These are designated as re-trapped cats. The re-trapping is necessary to maintain population counts at reduced levels and quantifies the inefficiency caused by cat immigration.



Total cats trapped	5400
New Cat Trapping	4080
TNR population reduction	1165
Cats pulled	1005
Total population reduction	2170
Reduction within TNR areas	60%
Island Population %	18%

Explanations:

- New Cat Trapping is the initial near-100% trapping that occurs when TNR is started in a new area. For example, if trapping was conducted in 50 areas, which altogether contained 600 cats when trapping started, then New Cat Trapping would equal or be very close to 600. However, after the initial trapping, additional trapping would occur in these areas due to immigration of new cats. This might result in total trapping of 750 cats.
- TNR population reduction is the attrition from natural causes or accidents.
- Cats pulled are the adoptable animals that were removed

TNR provides mitigation in addition to the direct population reduction because disease is reduced by 60% to 75% (see sources in main paper). Predation is reduced by 75% to 90% according to various sources (see main paper). Calculating both as a 75% reduction gives the following:

Reduction from 100% in TNR area	60%
Remaining cats in TNR area on average	40%
Mitigation of disease and predation	75%
% disease/predation remaining	10%
% of total neighborhood cats TNR'd	4080/12000 = 34%
Total island-wide mitigation	30%