ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

Alaska Department of Fish and Game
Wildlife Restoration Grant

GRANT NUMBER: AKW-23

PROJECT NUMBER: 7.01

PROJECT TITLE: Develop and evaluate indices for assessing marten population status and trend in Interior Alaska

PERIOD OF PERFORMANCE: July 1, 2017 – June 30, 2018

REPORT DUE DATE: Sept 1, 2018

PRINCIPAL INVESTIGATOR: Kerry L. Nicholson, Craig L. Gardner (retired), Alyssa Crawford (Biometrician), Mandy Keogh (Physiologist)

COOPERATORS: Knut Kielland (University of Alaska Fairbanks); Joe Cook (Museum of Southwestern Biology)

I. PROGRESS ON PROJECT OBJECTIVES DURING PERIOD OF PERFORMANCE

OBJECTIVE 1: Evaluate if fecundity based on pregnancy rates and blastocyst counts can be used as indicators of marten population status and composition for subsequent trapping season(s).

JOB/ACTIVITY 1A: Collect carcasses from the same trappers from the same areas and evaluate the young of the year: to adult female (YOY:AdF) ratios relative to the previous year's blastocyst counts and pregnancy rate. If there are no relationships, these data will indicate that either our methods of assessing pregnancy (presence of blastocysts) or counting blastocysts are not adequate or that YOY survival was lower than expected during the period between birth and the onset of trapping season.

This objective was completed in the prior reporting year. We did not collect carcasses for the 2017/2018 trapping season.

OBJECTIVE 2: Test the hypothesis that total YOY/AdF ratios of >3:1 are adequate for marten population maintenance.

JOB/ACTIVITY 2A: Compare sex and age ratios and total catch between years by trapper (trapper effort will remain comparable throughout the study).

ACCOMPLISHMENTS: We compiled and organized all the data to meet this activity. We have made progress on selecting the most appropriate analysis technique and will be providing summary reports to the managers and trappers in the next FY. A presentation was conducted by Alyssa Crawford towards the analysis (Appendix 1). Federal funds were used to pay for salary associated with this analysis.

OBJECTIVE 3: Assess how marten reproductive performance is related to diet and age by study area.

JOB/ACTIVITY 3A: Skinned marten carcasses were collected from trappers in study areas across the Interior during RY07–RY19.

ACCOMPLISHMENTS: We finished collecting carcasses in RY17 and finalized all the stable isotope data from the claw and muscle tissues in FY18. We compiled and prepared the data to begin analysis. Due to the collaborator's sabbatical we have been unable to proceed with the final analysis. Federal funds were used to pay for salary associated with this task.

Job/Activity 3b: Created a diet catalogue.

ACCOMPLISHMENTS: We finished sampling small mammal and other diet items of marten to develop the baseline catalogue of isotopic signatures to properly evaluate marten isotopic signatures in the previous reporting period. This objective is complete, and data will be incorporated into the larger nutritional analysis.

Job/Activity 3c: Assess stomach parasites and how this is related to reproduction and diet by study area.

ACCOMPLISHMENTS: Marten stomachs were sent to the Museum of Southwestern Biology. Since 2015, 300 stomachs have been inspected for parasite presence. Three undergraduate students have worked on the analysis and have presented preliminary findings at scientific conferences (Appendix 2). This is an ongoing analysis that has not been finalized by the time of this report. Federal funds were used to pay for salary associated with this analysis and contractual services provided by the museum to process, properly document and archive carcasses samples from this project.

Job/Activity 3d: Assess heavy metal contamination related to reproduction and diet by study area.

ACCOMPLISHMENTS: Adult female marten livers were being processed at the University of Alaska Fairbanks in the Wildlife Toxicology Lab. We recruited 3 volunteers to continue to process the livers in the WTL. Due to volunteer efforts 300 have been prepped for heavy metal contamination, though due to equipment failure only 120 have been completed. We will continue to process samples as the equipment becomes available. Federal funds were used to pay for salary associated with this analysis.

Job/Activity 3e: Analyze data of infection levels by sex, age, diet composition, geographic region and reproductive success

ACCOMPLISHMENTS: No work has been done on this activity as not all the data are available as of yet. When the individual analyses are completed, they will be compiled and analyzed as a group.

OBJECTIVE 4: If funding becomes available or if outside ADF&G cooperators become interested, assess the value of small mammal abundance indices as predictors for marten population status.

JOB/ACTIVITY 4A: Assess the status of small mammal populations during August–October and possibly during the spring in areas where carcasses are being collected.

ACCOMPLISHMENTS: We are done with data collection of marten and did not have the ability to pursue small mammal captures during the marten collection period. It is widely acknowledged that marten populations are reliant upon small mammal abundance and distribution. Therefore, this objective should be pursued, however it would be more feasible as a standalone project or incorporated into future marten research.

OBJECTIVE 5: Analyze and compare corpora lutea and blastocyst counts

Job/Activity 5a: We will assess the relationship between blastocyst and CL counts. We will remove the ovaries from the carcass and store in formalin until processing. Ovaries can be hand-sliced, however this method is less accurate than examining microtome sections that have been stained and examined with a microscope (Wright 1963).

ACCOMPLISHMENTS: We have compiled all counts of blastocysts from all years**.** Matson's laboratory processed all adult female ovaries from 2015/2016 trapping season. Preliminary comparison between blastocyst and corpora lutea counts indicate a strong inconsistency between these two metrics. They will not be directly comparable, therefore we will unlikely be able to determine the probability of missing a blastocyst in the counting procedure to obtain a level of accuracy regarding pregnancy rates. Federal funds were used to pay for salary associated with this analysis and contractual services provided by Matson's to count corpora lutea.

OBJECTIVE 6: Assess marten nutritional status affects fecundity

Job/Activity 6a: Assess body condition indices using omental fat.

ACCOMPLISHMENTS: Marten have been weighed, necropsied and omental fat removed. Omental fat has been weighed, freeze dried and weighed again. This objective is now complete, and data will be incorporated into the larger nutritional analysis.

Job/Activity 6b: Conduct a proximate analysis of the liver to determine nutritional condition.

ACCOMPLISHMENTS: The nutritional analysis will be conducted cooperatively with the University of Alaska Fairbanks. Proximate body composition will be assessed following methods similar to Whittaker and Thomas 1983. We recruited 3 volunteers to continue to process the livers in the WTL. Due to volunteer efforts liver samples from marten were freeze dried, then ground or diced for lipid analysis (n=172) and for nitrogen analysis (n=320). The lipid analysis was not completed due to equipment failure. We are seeing alternative labs to finish processing samples. Federal funds were used to pay for salary associated with this analysis.

OBJECTIVE 7: Assess reproductive and stress-related hormones

Job/Activity 7a: The body condition analysis.

ACCOMPLISHMENTS: We collected claw and hair samples from paws. We established sampling and processing protocols and began to extract cortisol and progesterone hormones from the hair. Federal funds were used to pay for salary and supplies associated with this analysis.

Job/Activity 7b: We will collect berry production indices climate variables from weather stations in proximity to the survey sites from GMU 12.

ACCOMPLISHMENTS: We obtained berry production indices from GMU 12 for years 2007-2016. This data will be incorporated into the analysis once the testing has been completed.

Job/Activity 7c: Determine what factors influence cortisol and progesterone concentrations, including the effects of reproductive status as determined by presence or absence of blastocysts and environmental conditions including precipitation (snow and rainfall) and berry production that have been tracked in GMU 12.

ACCOMPLISHMENTS: Hair and nail samples were collected from 60 female marten paws (2012=20; 2014=20; and 2016=20). Samples were cleaned, weighed, and ground. Steroid hormones were extracted from ground samples and standard methods including recovery of added mass, parallelism and dilution linearity were used to validate enzyme immunoassay kits (Arbor Assay) for cortisol, progesterone, and testosterone in hair and cortisol and progesterone in nails. Concentrations of cortisol, progesterone, and testosterone have been determined in all hair samples. Progesterone concentrations have been measured in the 60 nail samples. Cortisol and testosterone concentrations will be determined if enough volume of extracted hormones from nails are available. All biological (e.g., presence and number of blastocyst present) and hormone data have been compiled.

OBJECTIVE 8: Literature review, data analysis, and publications.

JOB/ACTIVITY 8A: Analyze data and prepare reports and manuscripts.

ACCOMPLISHMENTS: Federal funds were used to cover salary when conducting literature reviews on a monthly basis. Literature searches were conducted for information on marten population dynamics, productivity, and food habits, and on the use of harvest data to monitor furbearer populations and on stable isotope analyses to monitor dietary choice of carnivores.

We were analyzing the capture data with the intent of preparing a manuscript evaluating the use of easily collected samples from harvested marten to forecast population status by trappers and managers. We were also analyzing the data to identify any variables trappers and managers can monitor within season to track marten population status. During the reporting period we also worked on generating outreach publication that will be available for distribution this October (Appendix 3). Salary associated with these tasks was funded by federal aid.

II. SUMMARY OF WORK COMPLETED ON PROJECT TO DATE.

Not applicable.

III. SIGNIFICANT DEVELOPMENT REPORTS AND/OR AMENDMENTS.

None

IV. PUBLICATIONS

Draft rapid assessment of age and sex classes (Appendix 3)

V. RECOMMENDATIONS FOR THIS PROJECT

None.

Prepared by: Kerry L. Nicholson, Furbearer/Carnivore Wildlife Biologist III

Date: 07 August 2018

Appendix 1.

Using generalized linear models to refine management of marten trap lines

Alyssa L. Crawford, Kerry L. Nicholson, and Craig Gardener.
Alaska Department of Fish and Game

Introduction

American marten (*Martes americana*) have highly stochastic populations resulting in stochastic yearly harvest which can be problematic for trappers.

We have been working on creating monitoring metrics that can help trappers minimize overharvesting their populations.

One current method trappers use to monitor their population is to maintain a 3:1 juvenile to adult female ratio. However, aging adult females and small sample sizes are problematic.

Using a statistical model, we found the equivalent threshold for percent of juvenile to the common ratio threshold of 3:1.

Data

Trappers from interior Alaska donated marten carcasses (2007-2016) which were grouped by study area, juvenile (<1 year), adult (>1 year), and sex (female, male).

Generalized linear model

Let y_i be the number of juvenile with index of adult female f_i for year-area combination i. The sample rate is y_i/f_i with expected value y_i/f_i. Let x_i be proportion of juvenile for year and area i. A loglinear model for the expected rate has the form

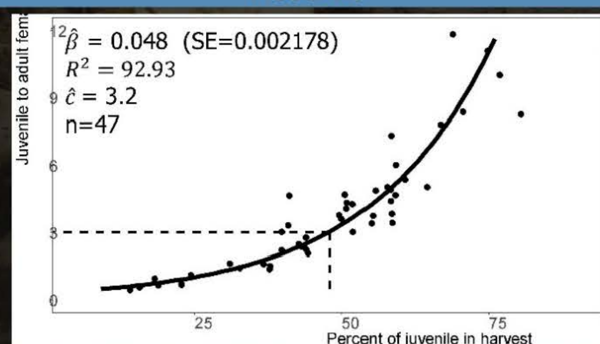
$$\log(\mu_i/f_i) = \alpha + \beta x_i$$

with the equivalent representation

$$\log(\mu_i) - \log(f_i) = \alpha + \beta x_i.$$

We used the above model and inverse prediction to find an equivalent threshold for percent of juvenile to the common ratio threshold 3:1.

Model fit



The above plot shows the observed data with the model fit. The dashed line indicates the important inverse prediction.

Inverse prediction

For inverse prediction, the estimated Poisson regression function is obtained as usual but solving for x given μ_i/f_i:

$$\log(\mu_i/f_i) = -1.12 + 0.048x$$
$$\log(3/1) = -1.12 + 0.048x$$
$$48 = x$$

When the average proportion of juvenile in harvest is ≥ 48%, (90% CI: 36.6, 72.4) , the average juvenile to adult female ratio tends to be ≥ 3:1.

Management implications

When a trapper is monitoring his/her catch, they should stop trapping when the percent of juveniles is less than 48% to reduce possible overharvest.

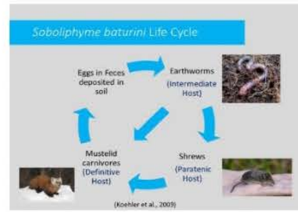
The new threshold is considered a "in-season check" that could be paired with predictive models. For predictive models, the reproductive metrics of the previous season are used to predict the percent juvenile in the next season.

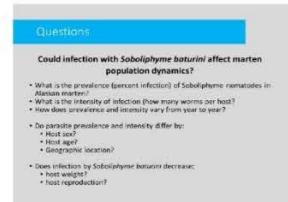
Appendix 2.

Patterns of Infection of American Marten (*Martes americana*) by the Nematode Parasite *Soboliphyme baturini* in Interior Alaska.

Monica Villegas, Quinn Ennis, Monica Naranjo, Steven Guerin, Elisa Gagliano, Mariel L. Campbell, Kerry L. Nicholson, and Joseph A. Cook. Department of Biology and Museum of Southwestern Biology, University of New Mexico and Alaska Department of Fish and Game.

Introduction





Materials and Methods

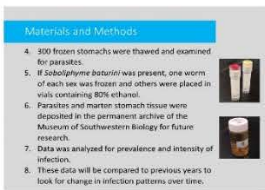


Figure 1: Map of Marten Collection Localities

Results

Prevalence

- The overall prevalence of *Soboliphyme baturini* in the 50 marten examined for this study was 22% (11/50), (Figure 2) compared to 37.3% (114/300) examined in 2015 (Figure 3).
- Prevalence of female worms was higher than prevalence of male worms. Out of 11 infected hosts, 11 (100%)were infected with female worms but only 6 (54% were infected with male worms.

Figure 2: Overall Prevalence of Infection in 2017

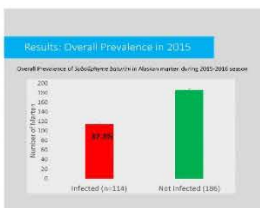


Figure 3: Overall Prevalence of Infection in 2015

Intensity

- Mean intensity of infection (number of worms per host) was 4 worms/host. Maximum intensity of infection was 13 worms/host (Figure 4).
- The distribution of infected hosts was slightly right-skewed, with most hosts having few (0-4) parasites and 2 hosts having >5. (Figure 5). This pattern is similar to the distribution of infection observed in marten in 2015-2016 (Figure 5).

Figure 4: Intensity of Infection Distribution in 2017

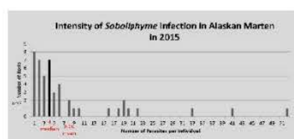
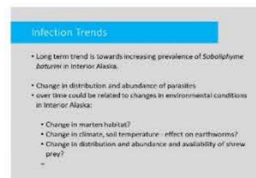
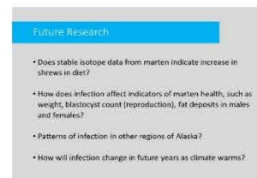


Figure 5: Intensity of Infection Distribution in 2015

Discussion

- Based on this initial sample of 50 marten collected in 2017, the overall parasite prevalence of 22 % was lower than the 37% found in 2015 (Figure 4) but higher than reported from two studies of marten parasites in the 1980s which found 0-0.7% prevalence of *Soboliphyme baturni* (Poole et al , 1983; Scranton, 1986).
- Intensity of infection was similar to previous years and earlier studies, with most marten hosts uninfected or having <5 worms per individual, and a few individuals with much larger numbers of worms.
- More 2017 samples will be need to be analyzed to compare patterns of infection over time and to address the effect of the nematode *Soboliphyme baturini* on marten health.
- Variation in prevalence and intensity through time and space may be a result of ecological factors affecting nematode transmission via shrews, the likely intermediate (paratenic) host. (Karpenko et al. 2007, Koehler et a. 2007, Thomas et al 2008).
- These parasites and hosts will be archived in the Museum of Southwestern Biology to act as a baseline for future research on wildlife disease and climate change in Alaska.





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Appendix 3.

Classifying age one method is to look at the development of the temporal muscles. Temporal muscles originate from the top of the skull along the temporal ridges. In young animals of both sexes, the temporal ridges are widely separated, but grow together (coalesce) as animals mature. The degree of temporal muscle coalescence classifies most juvenile martens correctly, but yearlings and adults are less reliable, especially for females.

For males, it is best to measure from the crest at the rear of the skull forward to the point where the temporal muscles diverge. A dividing point of 28.0mm worked for Southeast Alaska and 10mm for Interior marten.

For females the better indicator for age class was the minimum width between the muscles. A dividing point of 1.0mm works for most marten throughout Alaska.

Dried or desiccated skulls can lead to inconsistencies. As the muscle tissues dry out, they can shrink and expand the gap between the muscles.

Additional indicators of age that might be less consistent but still useful are sagittal crest development, teeth wear and the reproductive tracks of females.

Sagittal crest longer than 2 cm for males is probably not a young-of-the-year animal, and females with any development of the sagittal crest (with, consequently, no gap between the coalescence of the muscles) is likewise, not a young-of-the-year.

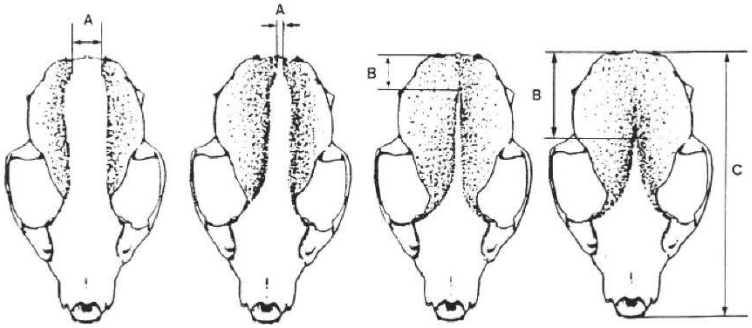
Tooth wear (especially canines) can provide a reasonable clue to the age class of a marten, but again, this must be used with caution. Differences in diet can create different wear patterns. Also, animals harvested with the use of leg-hold traps sometimes chew on the trap, causing premature tooth damage and abnormal wear.

Reproductive tracks of females can provide an indication of age. Animals that have not reached reproductive age (< 1 year old) possess small uteri. The uterine horns are narrow (<1mm), almost translucent and short (<45mm). Females who have been pregnant will have uterine horns that are stretched out of shape, opaque, and "thicker" horns.

Measurements of marten skulls used in analysis.

A = width between the temporal muscles (WBTM);
B = length of temporal muscle coalescence (LTMC); and
C = total skull length.

**Drawing and terminology adapted from Poole et al. (1994).*



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Why monitor your marten harvest?

American marten are the most trapped furbearer in Alaska. They are relatively easy to catch, and their pelts provide reasonable income for trapping effort. Marten are vulnerable to over harvest, so they can be difficult to manage. If trappers had ultimate control over the catch, the optimal strategy is to select for juveniles and avoid harvesting adult females as much as possible. As the harvest season progresses, the proportion of juveniles taken will decline as overall marten numbers dwindle. It is at this point where the resident breeding animals are harvested from the population— a point when trappers should reduce their efforts.

Because there is no way to control which marten are harvested, it is important to monitor the catch. In years of poor juvenile productivity, the depletion of the juvenile surplus will occur earlier in the season, thus increasing the possibility of overharvesting adults earlier. If the ratio of juveniles to adult females declines, trappers should consider reducing the number of active traps or close their lines entirely. Marten populations have a great ability to recover following even average years of productivity, so protecting the resident population can pay dividends but it will only work if trappers are paying attention.

Determining the age and sex of marten

The best method to determine age of a marten is by cementum analysis. This is a method that counts the yearly cementum layers of the tooth, much like counting tree rings as it grows. However, this method is expensive, time consuming and must be processed in a lab. There are several alternative methods to coarsely assess age and sex classes of marten in the field. We are providing the measurements we rely on most. No one method is 100% accurate, therefore using multiple indicators can increase confidence in your classifications.

American marten are sexually dimorphic

As in other members of the weasel family, male marten are larger than the females. Skull length is the easiest and most consistent measurement for discriminating between male and female skulls. There can be slight differences in subspecies and geographically with the dividing size between males and females. In Alaska, using a measurement of 81-82mm will correctly differentiate males from females. If a larger dividing point is used, it would increase the correct classification of females, but also increase the misclassification of smaller males.

For more information about marten, marten trapping, research, and managment go to the ADF&G website and look for marten under the Species tab. **http://www.adfg.alaska.gov/index.cfm?adfg=americanmarten.main**

Important notes about measurements:

- Uncleaned skulls can present difficulties because of the extra tissue covering the rear and front of the skull. Removing the facia as neatly as possible can assist in obtaining more consistent measurements.
- Skulls that have not been skinned cleanly where the cartilage from the nose or excess muscle and tissue on the upper jaw can cause errors in measurements. Make sure your measurements are bone to bone and do not include any muscle or other tissue.
- When measuring for the temporal muscle gap make sure you are measuring the gap between the actual muscles and not including connective tissue.

Hunters are important founders of the modern wildlife conservation movement. They, along with trappers and sport shooters, provided funding for this publication through payment of federal taxes on firearms, ammunition, and archery equipment, and through state hunting license and tag fees.

American Marten

(Martes americana)

A Field guide for rapid assessment of age and sex classes

The Alaska Department of Fish and Game
Division of Wildlife Conservation

2018

Marten Age and Sex Determination Key

1. Is the skull at least 3-1/4 inches (82mm)long?

No **Yes**

2. Is there a gap between the two temporal muscles on top of the head?

Yes **No**

Adult female

3. Is the gap between the two temporal muscles (at the narrowest point)more than 1/16 of an inch (1mm) wide?

Yes **No**

Juvenile female

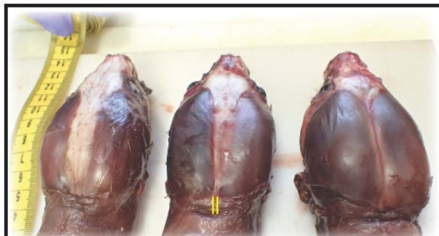
Adult female

2. Do the two temporal muscles on top of the skull meet for a distance of at least 3/8 of an inch (10mm)?

No **Yes**

Juvenile male

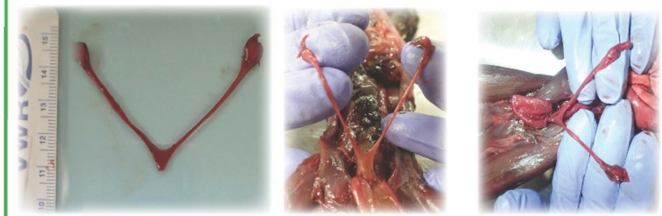
Adult male



An example of the progression of temporal muscle coalescence from juvenile to yearling to adult (left to right). This occurs when the animals are born in May until they reach yearling breeding age 14 months later, in July, and then into adulthood.

Uterine horns

Immature



Mature- has most likely produced young

Pregnant(?)

Teeth

Juvenile

Tooth wear inconsistencies

Tooth wear alone is not a reliable method of aging marten. The yearling above (A) has teeth wear similar to a juvenile. We only know it is a yearling by looking at temporal coalescence and the uterine horns as evidence and then confirmed it by cementum analysis.

Conversely, the juvenile below (B) has worn and damaged teeth that look more like what you would expect to find on an adult animal.

Adult