

Comparison Chart – General Notes

Physical Characteristics and Research:

Research in the past has centered on three major areas of study: (a) physiology of delayed implantation; (b) physiology of coat color changes (weasels); and (c) economic importance as fur bearers. Current research is studying their importance in the ecological balance of nature, declining populations, and value as an indicator species for an environmentally damaged ecosystem.

Delayed implantation

Most animals utilizing delayed implantation are northern animals, high in the ecological food chain, and without a rapid turnover of population (i.e., without a short life expectancy) so there is no need for multiple litters in a year. Mating in spring or summer is beneficial to the adults, while an early spring birth benefits the young because they have a longer time to mature and learn hunting skills before winter sets in. There is evidence that at least sometimes the male is around to help raise the young, because the female mustelids go into estrus soon after giving birth. In sharp contrast to domestic cats, the limited birth cycle also serves as a means of population control for such an efficient predator. In the case of Least Weasels, the lack of delayed implantation may be attributed to the need to produce more offspring being greater than the pressure for delay, due to the shorter life expectancy.⁶

Exposure to natural light and natural light cycles while in rehabilitation is important, as it has been shown to regulate behaviors, hormones, and molt cycles.

Mustelids are remarkable for their length and slenderness. As a comparison, the length of a raccoon spine = length of the hind leg; for weasels the spine = 1.75x hind leg. Minks are somewhat heavier but still slender enough to follow prey (especially muskrat) into burrows. Martens are similar in size to minks, while fishers are about 4x larger than minks or martens.

Mustela as a rule show little or no avoidance behavior although they become more alert in the presence of predators. Weasels in particular are the epitome ADD in the animal kingdom: high energy, very curious, easily distracted, and unintimidated by larger creatures (including humans).

Wild Minks vs Domestic (Farmed) Minks

Rescued domestic minks should not be released back into the wild – over one hundred generations of selective breeding for size, coat, and temperament has left them no longer equipped to survive well in the wild, and by interbreeding with wild minks they diminish the wild mink population. They also compete directly with wild minks for resources, may introduce disease to the wild population, and with their larger size drive the native minks out. There are rescue organizations for rehoming escaped farm minks, including M.I.R.R. (Mink International Rescue and Recovery, minkrecoveryteam@gmail.com or minkinternationalrescueandrecovery.com) and Rocky Mountain Mink Refuge, willing to offer advice and assistance for rescued domestic minks. Some key distinguishing features to determine if wild or domestic are 1) color – anything other than dark brown is probably a farm mink or hybrid, although pale or albino coloring in wild minks are occasionally seen; 2) size – domestic minks are often 2-3x larger, more if overfed (domestic minks are bred for larger body size, which provides a larger pelt; they do not portion control their eating, and will overeat to the point of obesity); the tail is often thicker on the domestic mink and the fur of the domestic mink is short and velvet smooth while wild minks have long guard hairs, giving native minks a shaggier, unkempt appearance. Domestic minks are bred to be less territorial than

Comparison Chart – General Notes

wild minks. An escaped farm mink may react with violent aggression to the sight of leather gloves while being calm, curious, and even friendly otherwise.

Defensive behavior

Mustelid defensive behavior follows set vocal and movement patterns which begin when the infant first opens their eyes. If caught in the open it follows a similar pattern to skunks: face opponent, stamp feet and charge. Size of adversary is irrelevant. Mustelids are curious and unafraid, including of humans. Same-species defensive behavior usually involves avoidance behaviors.

Medical Considerations

Emerging Disease

Farmed minks are known to be susceptible to both SARS-CoV-2 and HPAI, with high mortality; mustelids in general are susceptible to human respiratory infections. Biosecurity precautions should be taken, appropriate PPE should be worn, and good air circulation/filtration is important.

Medications (inject oral medications into the brains of food mice for ease in administration):

- Panacur (50 mg/kg PO sid) can be used for treatment of hookworms
- Fleas treated with feline/kitten Advantage (single application, 0.05 mL)
- Possible Pasteurella infection treated with Clavamox orally 2x/day (25 mg/kg PO bid) via food mice
- Infected bite wounds treated with Orbifloxacin (for gram negative bacteria) and Clavamox
- Stomach protectants should be given in conjunction with antibiotics. Omeprazole (Prilosec): 0.5-1 mg/kg PO once daily or famotidine (Pepcid): 1 mg/kg PO once daily
- Carafate (sucralfate suspension) 0.1 mL of 1g/100mL solution via food mice used to treat stress-induced ulcers until stool returned to normal.

Vaccines (AZA recommendations):

Canine Distemper: recommended to use the canarypox vectored CDV vaccine (PUREVAX Ferret Distemper Vaccine, Merial Inc., Athens, Georgia). Vaccinate every 3-4 weeks beginning at two weeks of age.

Least Weasel case study: vaccinated for canine distemper and hepatitis with two 0.2 mL sub-Q injections at two-week intervals.

Rabies: *Only a killed rabies vaccine product should be used.* The most commonly used is ImRab3 (Merial). Vaccinate at 16 weeks.

Adverse reactions: Animals experiencing an adverse reaction to a vaccine should be administered an antihistamine (e.g., diphenhydramine hydrochloride, 0.5-2mg/Kg IV or IM) or for severe reactions, epinephrine (20 µg/Kg IV, IM, subQ, or intra-tracheally), and supportive care.

Ferret Veterinarian Recommendations

Comparison Chart – General Notes

Vaccines. Do NOT pre-medicate with benedryl. This can mask the symptoms of a reaction, cause a delayed reaction, and some animals may possibly even react to the benedryl. If there's a reaction you want to be able to see it immediately and treat it. A reaction being masked is dangerous- you need to be able to see if there is ANY reaction, so that you can never administer that vac again. Most vets are using Dex-SP at 2 mg/kg IM 30 minutes prior to vaccination in ferrets. It's a steroid. Stay at the vet for at least 30 min after the shot. Make sure your vet is aware of the risks and ready to reverse a reaction, should one happen. Continue monitoring closely for 24 hours, and watch for swelling, redness, vomiting, etc. Never give rabies and distemper on the same day.

Vaccine reaction protocol for anaphylaxis in ferrets (would use the same for minks), Have protocol handy with dosages calculated prior to administering the vaccine, just in case:

- Epinephrine: 0.1 ml of 1:1,000 solution SQ and many need second dose. If a larger ferret or mink I would do 0.2 or even 0.3 ml.
- Diphenhydramine 2 mg/kg SQ, IM, or IV
- Dexamethasone-SP 2 mg/kg SQ, IM, or IV

Warm SQ fluids or if able IV usually start with 1/4 shock dose (25 ml/kg) and can give more if needed. Give flow by oxygen mask or intubation. Most ferrets turn around within 10-20 minutes and are ok with prompt care. Getting an IV line in is usually not possible, but if you can all the better. Symptoms of anaphylaxis include: vomiting, grey/white gums, coma/extreme lethargy/unresponsive, diarrhea and usually happen within minutes of vaccination. There can be delayed vaccine reactions which can happen hours to days later that are not as severe, nor need this protocol.

Sedation protocol – adult domestic mink: 0.5 mg/kg midazolam, 0.3 mg/kg butorphanol and 0.05 mg/kg dexdormator (with an equal ml of antisedan to wake up). All as IM injections.

Nutritional Requirements

Mustelid Adult Maintenance Energy Requirement (MER), kcal/day is: $70 \times \text{body wt. (kg)}^{0.75} \times \text{a factor of 4 (larger mustelids) to 8 (smaller mustelids)}$
Smaller animal => Faster metabolism; cold temperatures and high altitude => faster metabolism; younger => faster metabolism than older; nursing females have an extremely high calorie requirement.

Weasels and minks are obligate carnivores, with rodents or lagomorphs comprising the majority of their diet; fishers and martens (and some European weasels) are also obligate carnivores, but are known to eat berries and fungi when available. Offer young fishers foraged berries, such as mulberries, raspberries, and blackberries. Baby teeth, as well as the permanent teeth, are specialized for meat. The least weasel (LW) rarely eats anything other than small mice and voles and will generally starve when the rodent population crashes. The long-tailed weasel (LTW) has the most varied prey diet of the weasels, and the larger species (minks, martens, and fishers) are even more opportunistic, consuming prey, carrion, and occasionally berries and fungi. Evidence indicates they imprint on their food while young. This is important for rehabilitation because older juveniles and adults may not recognize unfamiliar food (such as commercial pet food) as food, and it also indicates the young animals should be exposed to multiple appropriate natural food, including insects, to facilitate survival post-release. Dry pet food should not be fed to any mustelid, and feeding cat kibble to animals in rehabilitation may encourage them to forage at feral and outdoor cat feeding stations, leaving animals more susceptible to predation, disease, and human conflict.

Comparison Chart – General Notes

If feeding “people” meat, fish, and eggs, raw is better than cooked, because the cooking may cause key nutrients to be less available. They are evolved to eat their proteins raw. This should be balanced with the risk of contaminants picked up during the food processing process. All supplements/ commercial products should be animal-based, not plant-based, as they may not absorb or metabolize the plant-based carbohydrates. If not fed whole prey then the diet should mimic whole prey, including skin, organs, small intestines (for partially digested carbohydrates)^{6, p127}, and bones.

Taurine

While many animals, including humans, produce taurine, obligate carnivores, including mustelids and felids, are required to get taurine (an essential amino acid) from their food, as their body cannot produce it. Muscle meat is high in taurine, as are spiders, many insects, and (apparently) brains and eyeballs. Chicken baby food, chicken dark meat, clams/clam juice, tongue, and heart are good sources of taurine. Kitten and Zoologic Milk Matrix formulas are recommended because they contain supplemental taurine, as do most Fox Valley formula powders. Review formula ingredients carefully, as formulations may change over time. Taurine is present in the colostrum and milk of many mammals, and is present at particularly high levels in the milk of obligate carnivores. The recommended taurine supplementation for mustelids is 250 mg/animal/day.

Taurine deficiency causes alterations in excitable tissues in all species; retinal degeneration, myocardial failure, dilated cardiomyopathy (DCM), and reproductive issues are the most common in domestic cats, but also seen in other species, if taurine levels are depleted. Common ways cat owners cause taurine deficiency and related conditions are feeding dog food, feeding boiled poultry, and feeding boutique diets without adequate taurine – this would all apply to mustelids as well.

Young Mustelids

Young mustelids are called “kits”. At birth the front limbs are much stronger and better coordinated than the rear limbs. Newborns are surprisingly strong, lifting their heads high and briefly supporting on fore legs. They react with loud(!) vocalization when disturbed or separated from the mother. This diminishes rapidly as they get older and generally ends by the time their ears open. It takes quite a while for the back limbs to become strong and coordinated. Larger species take longer to become fully coordinated than smaller species.

Nutrition

Because of their high metabolism young mustelids require frequent small meals, along with water to digest it; for weasels this means 5-10 small meals per day spaced 2 - 3 hours apart with constant access to fresh water. Minks can be fed less often, but should also always have access to food and water. Mustelids cannot consume more quantity per meal (i.e., gorging) or eat more frequently even if underfed, due to limited stomach capacity. Smaller animals require more food relative to their size than larger ones. LW > short-tailed weasels (STW) > LTW; ♀ > ♂; young>old. Mustelids store very little energy as fat, which increases their reliance on frequent meals. Minks and fishers, especially the males, will not have attained their adult size prior to release, so will have additional energy requirements to support their still growing bodies.

Young LTW must eat 50-100% body weight (BW)/day while adults require 25-30%/day. An adult male LW requires 40% BW/day.

Comparison Chart – General Notes

Mustelid Maternal Milk Composition is high protein, high fat, low carbohydrate, low fiber. Of the documented mustelid maternal milks, the range for proteins is 26-40%, for fat it is 31-45%, and for carbohydrates it is 8-21%. Mink is 33% fat, 26% protein, 21% carbs on a dry weight basis and contains 3.8% lipids, 6.2% protein, 4.6% lactose and 10.66% mineral salts as is. Zoologic states mink milk is 26% protein, 33% fat, 21% lactose, 21.7% solids. Weasels appear to need higher fats and proteins (and less carbohydrates) than minks, while fishers require a more balanced fat/protein/carbohydrate formula. All mustelids require taurine to be provided in their diet, and minks require a fish oil supplement.

I have used KMR: Multi Milk: water, 3:1:6; I am currently using 4 parts Fox Valley (FV) 32/45 (skunk) : 1-part Goat Milk KMR : ½ -part MultiMilk : 8 parts water for weasels and minks. I use distilled or filtered water for mixing formula, and filtered water for drinking. The minks should also be supplemented with fish oil at least daily. For fishers, I recommend Pet-Ag Milk Matrix 33/40 over Esbilac, Goat Milk Esbilac, or Fox Valley 33/40. I prefer KMR and FV Kitten over the non-cat equivalent because it is more likely to have adequate taurine; Zoologic Milk-Matrix and Wombaroo formulas are low lactose and often have supplemental taurine. Milk Matrix 30/52 is equivalent to Multi Milk; both are a fat booster, but also a nutritionally complete powder, and can be used at either standard dilution or simply added as a fat boost with no additional water. Read the labels! Larger species of mustelids may require less of a fat boost than smaller ones.

Formulas based on goat's milk may be beneficial because small mammals cannot efficiently absorb the fat globules in cow's milk. Straight up goat's milk is too high in carbs and too low in fat and protein for mustelids, and the taurine level is unknown. Goat Milk KMR is now available.

It is important to offer moist solids to weasels and minks (cut up, ground, or pureed whole mouse, fresh or frozen-thawed raw feline diet, or high quality [no grains, veg, or fruits!], or soaked kitten kibble) from a very early age (3 weeks) and to continue offering formula on the 2/2.5/3 hr., 24/7 feeding schedule as they begin eating solids. Fishers do not start eating solids until after their eyes open. Once the animal's eyes open it often becomes difficult to hand feed with a syringe because they do not want to be held. Formula should then be offered in a dish for as long as any individual in the enclosure is interested in taking it. This will help to ensure the young orphan is receiving adequate nutrition, especially calcium and fluids, and also sufficient calories. It is hard for them to eat enough calories in a day without the formula, especially when very young. Kibble, if used, should be fed moist, as they need the water to digest the food. Body weights of weasels can vary by as much as 20% depending on how recently they last ate or defecated.

Syringe feed only if the kit is warm and vigorous. Weak kits may be hypothermic, dehydrated, and/or hypoglycemic. Do not offer anything by mouth until the body temperature is within the normal range for its age. Offer weak individuals diluted carnivore critical care food, or diluted [human] baby food chicken, if it will accept, or give oral or SQ fluids if extremely weak or dehydrated. Be very cautious about administering sub-Q fluids, as it easy to overwhelm their system. Oral fluids (with added protein for calories) are preferred. Rub maple syrup, molasses, or Karo syrup on gums, or offer 2.5% or 5% dextrose to raise glucose level, if necessary. Be extremely cautious about tube feeding, as the stomach capacity is small, and the danger of over-feeding or introducing food into a shut-down system is high.

RodentPro has prepared a table with detailed food composition data on the nutritionally important components of whole vertebrate prey items excluding fish. It can be found at <https://www.rodentpro.com/informationcenter/resources/nutrient-composition-of-whole-vertebrate-prey>

Housing

Comparison Chart – General Notes

Depending on the information source, neonates should be kept at a temperature ranging from 80 – 85°F or housed in incubators set at 85-90°F and 50-60% humidity; however, young animals die very quickly if they are kept at too high a temperature, and higher temperatures lead to dry skin. As the fur comes in the temperature should be gradually reduced to room temperature (70-75°F) over the course of about 3 weeks (unless the animal is not thriving). If the ambient temperature is too high it may cause hair loss. Weasels will feel more secure if burrowed in layers of towels, flannel, fur, or fleece; this also aids in keeping them warm and allowing self-adjustments of temperature. Minks and fishers will quickly move away from heat and covers as their juvenile fur comes in. Singles will often do much better with a comfort heartbeat/Snuggle Pet.

Dry skin may be treated by topical application of olive oil with a cotton applicator or cotton ball; in addition, minks should be getting daily supplemental fish oil with their food.

Important to successful rearing: 1) **Keep kits warm, and offer them a temperature range** (fur or fleece stacks and heating pad, or incubator with fur or fleece for neonates); 2) **provide hiding places** (layers of fleece, fur, or flannel pieces, cage curtains and sheer fabric drapes on portions of the walls, huts, hide-away toys, pieces of pvc pipe, paper tubes, etc.); 3) **consistent staff, limited to the fewest individuals** (kits with their eyes closed can react aggressively to strange smells, and unfamiliar caregivers may cause considerable stress to the animals); and 4) **frequent feedings** (10 – 14x/24 hrs. until supplementing with solids, then gradually reducing frequency to 8-11x/24hrs while maintaining regular intervals with night feedings until they are no longer interested in syringe feedings). Remember that they require 50-100% BW/day in food. After their eyes open formula can be offered in a shallow dish until they are no longer interested. Ideally there are two or three caretakers, so night feedings can be alternated. If there is a single caretaker, it is important for the caretaker to get one 4-hour block of sleep each night, to encompass a full sleep cycle, in addition to shorter blocks of sleep, otherwise mistakes *will* happen, potentially with lethal consequences for the kits (or the caretaker).

Adult minks are capable of biting through chicken wire and potentially through hardware cloth, and have been known to bend the bars of ferret and critter nation cages with their teeth. All mustelids are very fast and stealthy. Critter/ferret nation cages should have all sections/walls/top panel zip tied together, and the doors should be secured with a carbineer and zip tie system.

Do not house mustelids with other species, including/especially other mustelids (with the possible exception of skunks and smaller weasels), as they are all in a predator-prey relationship with each other.

Maintain in a cool environment (ideally <70 °F) and use heat lamps, heating pads, hot rocks, fleece bedding, etc. to provide warm areas.

The mustelids are all scent markers and sensitive to scents. To minimize stress, per AZA recommendations, clean or replace only 25% of the bedding and enrichment at one time rather than “clean sweep”. They tend to have corner “latrine” areas which facilitates spot cleaning. Also, be aware they cache food, often in a tunnel system (toilet paper tubes, pvc pipes, etc.) and periodically replace/clean those as well. They are sensitive to essential oils, and many essential oils have been found to be toxic for ferrets at low levels (including common ones like tea tree and eucalyptus). Avoid using or wearing scented products in their area.

Use natural substrates in outdoor enclosures, such as dry sphagnum moss, hay, soil, pine needles, leaves, sand, mulch or bark, etc. with good cover and abundant climbing, foraging, and resting sites. Chopped grass forage (Triple Crown Grass Forage) with a tunnel system of paper tubes (indoor caging) or narrow (1-3”) pvc pipe (outdoor caging) is nice base for small weasels, with branches, logs, rocky screes, nest boxes, and hiding

Comparison Chart – General Notes

spots. Hammocks, cat trees, trampolines, saucer tree swing, and wall hangings such as burlap sacks or curtains are popular with weasels, minks, and fishers. Dense furnishings are necessary for psychological well-being.² Minks need a pool they can easily climb in and out of, with enough space to swim and dive, as well as a drying off area. Weasels will extensively use a sugar glider exercise wheel (e.g., Stealth Wheel) and larger animals (long-tailed weasels, minks, fishers) will use a cat wheel; this is an excellent outlet for energy and stress, and helps to meet the need for exploration and ranging.

Mustelids are sensitive to photoperiods. Natural photoperiods should be maintained when housed indoors. This is especially important for adult animals as photoperiods are known to indirectly control both molt and some changes in the sexual cycle.

Survival after release is greatly enhanced if the animal is housed in a simulated natural environment (lots of cover and tunnels) and provided opportunity to track and hunt prey. Sufficient space is necessary to facilitate and encourage predator avoidance tactics (quickly run away; hide). The optimal release window is late summer/early fall; the lowest survival is when release is from late fall to early spring.

Large litters (more than 6 weasels, more than 4 minks) may be divided after weaning by size or bonded buddies. Even with ad lib food available the larger animals may prevent the smaller ones from getting sufficient nutrition, as well as causing stress by aggressive behaviors. There may also be increased aggression, especially with minks and fishers. Watch for pair bonds and try to respect their “favorite buddy” choice, both in care and when released. In captivity, intraspecific aggression appears in fisher kits when they are about 3 months old, and they may be intolerant of each other by 5½ months, at which point they must be released or separated.

Cited references:

¹*National Audubon Society Field Guide to Mammals*, 1996 rev;

²*Mustelid (Mustelidae) Care Manual*, Association of Zoos and Aquariums, July 2008, revised January 2010;

³*American Weasels*, E. Raymond Hall, August 2015 (written over the past 25 yrs.);

⁴“The Least Weasel *Mustela nivalis* Linnaeus, Developmental Biology in Comparison with Other North American *Mustela*,” Biological Series Volume 4, Number 7, Publications of the Museum, Michigan State University, Gary A Heidt, April 1970

⁵East and Lockie, Edinburgh

⁶*The Natural History of Weasels and Stoats*, Carolyn M. King and Roger A. Powell, 2nd edition, 2007

Additional Resources:

Professional Standards

- AVMA Guidelines for Euthanasia of Animals
- NWRA Wildlife Formulary
- NWRA/IWRC Standards for Wildlife Rehabilitation
- NWRA Principals of Wildlife Rehabilitation
- NWRA Wildlife Rehabilitators Code of Ethics (https://www.nrawildlife.org/page/Code_of_Ethics_Rehab)

Comparison Chart – General Notes

- GFAS Standards For Caniform Sanctuaries, 2019 or most recent version. <https://sanctuaryfederation.org/wp-content/uploads/2020/02/Caniform-Standards-2019.pdf>
- One Health Initiative, <https://onehealthinitiative.com/>
- AZA Mustelid (Mustelidae) Care Manual
- Carpenters Exotic Animal Formulary

Academic texts and supplemental reading:

- The Fisher. Life History, Ecology, and Behavior, Roger A. Powell, 1st edition (1982) and 2nd edition (1993)
- Food Composition Data: RodentPro has prepared a table with detailed food composition data on the nutritionally important components of whole vertebrate prey items excluding fish. <https://www.rodentpro.com/informationcenter/resources/nutrient-composition-of-whole-vertebrate-prey>
- Fowler's Zoo and Wild Animal Medicine, Volume 8, Chapter 48 - Mustelidae, George V. Kollias, Jesus Fernandez-Moran. 2015. R. Eric Miller, Murray E. Fowler, eds. <https://doi.org/10.1016/B978-1-4557-7397-8.00048-7>
- The Least Weasel *Mustela nivalis* Linnaeus, Developmental Biology in Comparison with Other North American *Mustela*,” Biological Series Volume 4, Number 7, Publications of the Museum, Michigan State University, Gary A Heidt, April 1970
- The Lone Wolverine: Tracking Michigan's Most Elusive Animal, 2012, by Elizabeth Philips Shaw and Jeff Ford
- Martens and Fishers (Martes) in Human-Altered Environments, edited by Daniel J. Harrison, Angela K. Fuller, and Gilbert Proulx, 2004
- Medical Management of Wildlife Species: A Guide for Practitioners. Abou-Madi, N. (2019). Natural History and Medical Management of Mustelids. In Medical Management of Wildlife Species (eds S.M. Hernandez, H.W. Barron, E.A. Miller, R.F. Aguilar and M.J. Yabsley). <https://doi.org/10.1002/9781119036708.ch22>
- The Natural History of Weasels and Stoats, Carolyn M. King and Roger A. Powell, 2nd edition, 2007
- Parasites and Diseases of Weasels, Ecology Center, <https://www.ecologycenter.us/common-weasels/parasites-and-diseases-of-weasels.html>
- Walker's Mammals of the World, Volume 1. Donald M. Nowak, 6th edition, 1999
- Wild Mammals of North America, edited by George A. Feldhamer, Bruce C. Thompson, Joseph A. Chapman, 2nd edition, 2003
- Winter of the Fisher, 1971, Cameron Langford
- Winter World, Bernd Heinrich, 2003 – and really, anything by Bernd Heinrich is worth reading
- The Wolverine Way, by Douglas H. Chadwick, published by Patagonia Books