

FELINE LEUKEMIA VIRUS IN FLORIDA PANTHERS: MANAGEMENT RECOMMENDATIONS

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I. Background

The current outbreak of feline leukemia virus infection (FeLV) in the Florida panther population is an unprecedented event – outbreaks of FeLV in free-ranging non-domestic felids have not been documented. Further, we know of no reports concerning the introduction and/or eradication of any infectious disease from a free-ranging non-domestic felid population. Therefore, decisions concerning the management of this outbreak must be based on data from domestic cat models and panther ecology, and adapted as we learn more about the outbreak in panthers.

Vaccination followed by booster using Fel-O-Vax® Lv-K (Fort Dodge Animal Health, Fort Dodge, Iowa) or Fevaxyn-FeLV® is safe and relatively effective (90-100% efficacy) in domestic cats (Sherding, 2000; Sparkes, 2003). Although a single inoculation may provide some protection, boosters are necessary to adequately protect against FeLV infection. Panthers may receive boosters by treeing and darting with vaccine, or at recapture. Side effects of vaccination may include cancer in 1-3/10,000 domestic cats vaccinated; however, the most significant risks are associated with capture and darting. Computer modeling of FeLV in domestic cat populations suggest that 23-72% of the population must be protected by vaccination to achieve control in a population having a 10% prevalence of FeLV (Lubkin et al., 1996). As of 1 September 2004, 12 vaccinated and boosted (or otherwise previously exposed) free-ranging Florida panthers were alive – representing approximately 12 to 15% of the population.

Following the initial detection of FeLV in the Florida panther, experts in feline virology and wildlife medicine were consulted for advice on the management of the outbreak. Initially the belief was that this disease was going to be slow moving and localized – and that removal of infected panthers would not be a necessary to control the disease. Published literature also supported this belief. Levy (1999) stated that “true ‘outbreaks’ of FeLV infection are unlikely to occur” and Kennedy-Stoskopf (1999) argued “[t]he lack of antigen-positive animals and absence of clustered clinical cases with FeLV-related diseases are evidence that the virus is not maintained in [free-ranging non-domestic felids].” However, the finding of three additional FeLV positive panthers this capture season essentially confirms the disease is becoming established in the panther population and that the rate of transmission is likely much greater in panthers than in domestic cats. The apparent transmission of the virus from FP123 to FP132 following a single bite wound supports this speculation. Further, behavior of the virus in culture indicates that this strain may be more virulent (K. Hayes, unpubl. data). It is also possible that the panther is more susceptible. Some panthers retain an original or authentic genotype (‘pure’ panthers) and have a much lower genetic diversity compared to Florida panther/Texas cougar intergrades. Indeed, four of the five FeLV-positive

panthers are believed to be pure (although genetic analysis has yet to be completed and the distribution of pure panthers and intergrades is geographically skewed).

There are four goals in the control of this epizootic; first, to prevent the disease from moving from the northern portion of panther range to the core of the population; second, to reduce or eliminate FeLV-related panther mortality in the northern portion of panther range; third to eradicate the disease from the population; and fourth, to prevent or minimize the risks of future introductions. Vaccination is the primary management tool to eliminate FeLV in domestic cat populations, and will be the primary method employed by the Florida Fish and Wildlife Conservation Commission (FWC) and National Park Service (NPS). However, because much of the land between the endemic area and public lands to the south is private, FWC does not have access to capture and vaccinate panthers in this area. Vaccination of panthers on these lands may be accomplished indirectly by vaccinating panthers on the periphery, vaccinating juveniles that may disperse into the endemic area, and/or releasing vaccinated panthers on public lands in the endemic area. However, boosters should be administered approximately 4 weeks after initial inoculation. Movement of panthers receiving an initial inoculation onto private lands may prevent administration of boosters in some individuals and thus reduce the efficacy of vaccination. Due to the limited ability to vaccinate and booster panthers in the area, and the probable failure to achieve the recommended 23-72% effective vaccination, the removal of persistently infected individuals may be necessary to augment vaccination.

The removal of FeLV positive individuals is an effective component of control programs in domestic cats although secondary in importance to vaccination. Together the two control methods work synergistically to eradicate FeLV from domestic cat populations. In wildlife populations, removal is a recommended management tool for slow-moving diseases and diseases in threatened or endangered populations – especially in “situations where it is necessary to control a disease while conserving as much genetic stock as possible.” (Wobeser, 1994).

The outbreak in panthers is an unprecedented event and at this time we do not know how the virus will behave in the population. Therefore our management actions should be flexible and evolve as we learn more about the epizootic. Current information indicates that:

- 1) We are relatively early in the outbreak and, to the best of our knowledge, the disease is geographically limited to the northern portion of panther range.
- 2) The disease is transmitted more readily among panthers than among domestic cats.
- 3) The disease is being maintained in the population.

To re-evaluate our management plan, a summary of our findings and a solicitation for feedback concerning management options was prepared. In February 2004 this document was e-mailed to experts in the field of feline virology, Florida panther ecology, wildlife veterinarians, and epidemiologists. An important question in this document concerned the removal of infected panthers. Although there was not a consensus, the vast majority of respondents advised removing infected panthers (especially male panthers) (Table 1).

Those favoring the removal recognized that the decision would be difficult, but were relatively strong in their opinions. Dr. Legendre (University of Tennessee, College of Veterinary Medicine) stated that he “...would strongly consider taking [FeLV positive

males] out of circulation.” He went on to describe an infected adult breeding male as a “transmission machine.”

The major points of concern (in bold) among those surveyed are valid and paralleled the concerns of FWC personnel. These concerns are addressed below.

1) Removal of infected panthers would interfere with the investigation of the epidemiology of the outbreak. Management of disease in wildlife populations ideally should begin only after the ecological consequences of the disease in question have been determined (Peterson, 1991). Observing the behavior of the virus in the panther population would provide unique insight into the epidemiology of the disease in free-ranging non-domestic felids. Further, as pure panthers appear to be more susceptible, allowing the disease to progress would allow us to further compare the immunocompetence of pure panthers versus intergrades. Relatedly, by employing management efforts early in the outbreak, if eradication is achieved we will never know if it was due to our efforts or if the disease would have died out on its own. Critics may say that removal was unnecessary because the outbreak would have ended anyway. But we cannot ignore the evidence that the disease is indeed being transmitted among panthers and has the potential to spread throughout the population. Further, the infection and subsequent death of FP132 is possible evidence that intergrades are also susceptible to the virus.

We do not have the luxury of simply observing the natural epidemiology of the disease in panthers to see if the disease does in fact disappear without intervention. With a population that numbers 80 or less, the loss of even a few individuals will have an impact. Additionally, vaccination of free-ranging panthers has already begun so the natural course of the infection in the population has already been disrupted.

Finally, the argument of letting nature take its course does not apply to this situation, as FeLV is an exotic disease that is novel to the panther population, i.e., the panther has not evolved with this disease.

2) It is unethical to remove an adult free-ranging carnivore and place it permanently in captivity. Speaking for practically everyone involved, nobody is comfortable removing an adult wild panther to captivity. However, the health of the population takes precedent over the individual. Although details have not been worked out, it is possible that infected individuals can eventually be placed in a secluded outdoor pen (approximately 5-10 acres).

3) Removing infected panthers creates a vacant home range in the endemic area. An uninfected panther may move into the home range only to become infected by FeLV positive resident panthers. The removal of infected individuals creates a vacant home range that a susceptible panther could move into. Theoretically, these immigrants could then be infected by FeLV-positive resident females or males. Indeed, modeling of FeLV in domestic cat populations indicate that removal of infected cats from one population followed by immigration from a susceptible population has a negligible effect on FeLV prevalence (E. Fromont, unpubl. data). However, the presence of a known infected panther presents an absolute risk while the immigration and subsequent infection of susceptible panthers is only a theoretical risk. For the latter to occur, there would have to be infected panthers present, and they would have to infect the immigrant. In a worst-case scenario, if all of these factors came together, we would end up back where we started – with a positive panther replacing the one removed. Even if this

occurred, the removal may still delay the spread of the disease thus allowing more time for a greater proportion of the population to be vaccinated. Further, a new panther moving into this vacant territory may already be vaccinated, or previously exposed and thus theoretically protected. Finally, while, at worst, the removal of infected panthers and subsequent creation of vacant home ranges may result in a population sink, it will reduce the potentially more devastating possibility of the dispersal of infected individuals into the core population.

4) Removal of infected panthers may be unnecessary if they die before spreading the virus. Indeed, the virus does apparently result in fatal disease more quickly in panthers than in domestic cats. On average there is a 50% annual mortality in persistently infected domestic cats, and some infected adults often remain healthy for several years. However, the time between diagnosis and death for four panthers averaged 8.5 weeks (range 2-22 wks); time from known exposure to death in FP132 was 16 wks. Nevertheless, the persistence of the virus in the population is evidence that effective transmission is occurring before mortality. This is illustrated in the case of FP123 who transmitted the virus to FP132 before being killed.

5) The removal of infected panthers sets a precedent obligating us to remove all panthers that test positive. The issue of setting a precedent has been the most important criticism concerning the removal of infected panthers. This is a valid concern and one which is difficult to address, as we do not know how this outbreak is going to progress. As mentioned, this is an unprecedented event and we are still early in the course of this epidemic. However, this fact actually helps us with the precedent issue – it gives us the freedom to adapt our management strategy as we learn more about how the virus is going to behave in the population. Indeed, as Dr. Scott Citino advised, we should evaluate each FeLV-positive case independently, based on all factors involved at the time, rather than have a set protocol.

6) The removal of infected Florida panthers results in the loss of genetic representation for these individuals. This loss is definite while the gain in lives saved is only theoretical. For this reason removal was not considered a valid option last year when only two panthers tested positive. However, the finding of three additional positives this year suggests that the disease is spread more easily among panthers than originally thought. Additionally, the apparent virulence of this virus in panthers will likely limit the reproductive potential of infected panthers as the average life span after diagnosis is only 2 months. Infected females are unlikely to successfully give birth to kittens or survive long enough to raise them to maturity. Further, if kittens were produced, they would most likely become infected and die before reaching dispersal age.

II. Recommendations

1) At this point in the investigation and management of FeLV in panthers, we recommend that all panthers that test FeLV-positive in the field should be removed to captivity. If additional testing confirms the infection then the panther would remain in captivity until it clears the infection or succumbs to the disease. Release may be considered if the panther clears the infection (panthers clearing the infection should be kept in captivity until >1 yr after resolution of IFA positive status). Euthanasia of persistently infected panthers may be considered.

Draconian measures, such as removal of positives, are indicated as these types of actions early in the outbreak may significantly delay the spread or even eliminate the disease. Further, it may be unwise to depend on a single method (vaccination) to protect the population; especially when the vaccine has not been thoroughly tested in panthers and effective protection may be less than 100% in domestic cats (Sherding, 2000). Should the vaccine prove ineffective in panthers, or if FWC, for whatever reason, was unable to field a capture team, then the population may go unprotected.

Although the removal of infected panthers will likely generate controversy and criticism, the failure to remove an infected panther, and thus placing other panthers at risk, may generate greater criticism. Additional benefits associated with the removal of infected panthers would be the ability to monitor the progression of disease in a controlled environment, and to have access to live virus for culture, isolation, and pathogenicity studies. For these reasons, removal could also be considered a research tool in addition to a management action. Finally, this action could contribute to the re-establishment of a captive population. Captive breeding of infected panthers with vaccinated panthers/cougars may be considered. At the very least semen from infected captive cats could be collected and saved for future artificial insemination of vaccinated females (virus is secreted in the semen).

Options for temporary captive placement include the Lowry Park Zoo, Jacksonville Zoo, Homosassa Springs State Wildlife Park (Homosassa, FL), and the Wildlife Research Laboratory (Gainesville, FL). An infected panther could be held at either of these facilities pending confirmatory testing. If persistently infected, permanent placement should be arranged or euthanasia should be considered. Currently, the primary option is to remove infected individuals to Lowry Park Zoo where the panther could be held indefinitely. There is a veterinarian (Dr. Dave Murphy) and full-time carnivore keepers on staff. Currently a carnivore pen is available. As direct contact is necessary for transmission, other captive panthers (FP207, 208) would not be at risk. A proposal by Lowry Park Zoo is in place to build a larger outdoor pen for captive panthers in Green Swamp. An infected individual(s) may be removed to this pen following completion (although precautions should be taken to avoid possible transmission to bobcats).

2) To prevent southward expansion of the endemic area, first priority for captures (vaccination and test-removal) should be on private lands south of Okaloacoochee Slough (OKS). If these areas are inaccessible then priority should be given to the Addition Lands (Big Cypress National Preserve [BCNP]). Second priority should be the Big Cypress-Seminole Indian Reservation and Bear Island while third priority is OKS. Fourth priority would be all other lands north of I-75. Fifth priority is BCNP between I-75 and US41 while BCNP lands south of US41 are sixth priority. Last priority is areas more or less geographically isolated from the core of the population (Everglades National Park, Sarasota, etc.).

3) Booster vaccinated panthers at least 4 wks post-initial inoculation according to the flow chart in Figure 1. Boostering panthers is logistically difficult and dangerous to the panther; nevertheless, alternatives such as a slow-release injection or implants are not currently available. Further, the vaccine must be refrigerated until use. Therefore, even if an implant were developed, the vaccine would be at body temperature for a month before being released.

4) Continuation of a second capture team (NPS) should be encouraged. This team should give priority to BCNP lands just south of I-75.

5) Unvaccinated radio-collared panthers, especially adult males, should be captured and vaccinated if north of US41. These are panthers that can be captured with relatively little time investment. Private land access to capture and vaccinate (or remove if FeLV-positive) FP65 should be obtained.

6) In certain situations, consider suspending the dependent kitten protocol in order to increase the number of vaccinated individuals. This will only rarely be necessary as, in theory, family groups should not be coming into direct contact with other panthers, and thus should not be at risk of exposure until the kittens have dispersed.

III. Summary

In summary, FeLV appears to be more aggressive in panthers than domestic cats, and currently appears to be geographically restricted to the northern portion of panther range. Because of this distribution we are in a good position to prevent the spread of the disease into the core of the population. Although a vaccination program is underway, we will not be able to achieve the goal of having 50-75% of the population vaccinated for at least another 1-2 years. Further, the presence of large tracts of private land in the northern portion of panther range impairs our ability to vaccinate and/or booster panthers in this area. The limited ability to vaccinate in the north combined with the restricted geographic distribution of the disease, and the uncertain efficacy of the vaccine in panthers begs the rapid employment of additional management options, i.e., removal of positives. As we learn more about the disease and as a greater proportion of the population is vaccinated, then removal of FeLV positives may no longer be necessary. Finally, although removal will undoubtedly be controversial, failure to remove infectious panthers may generate greater public criticism.

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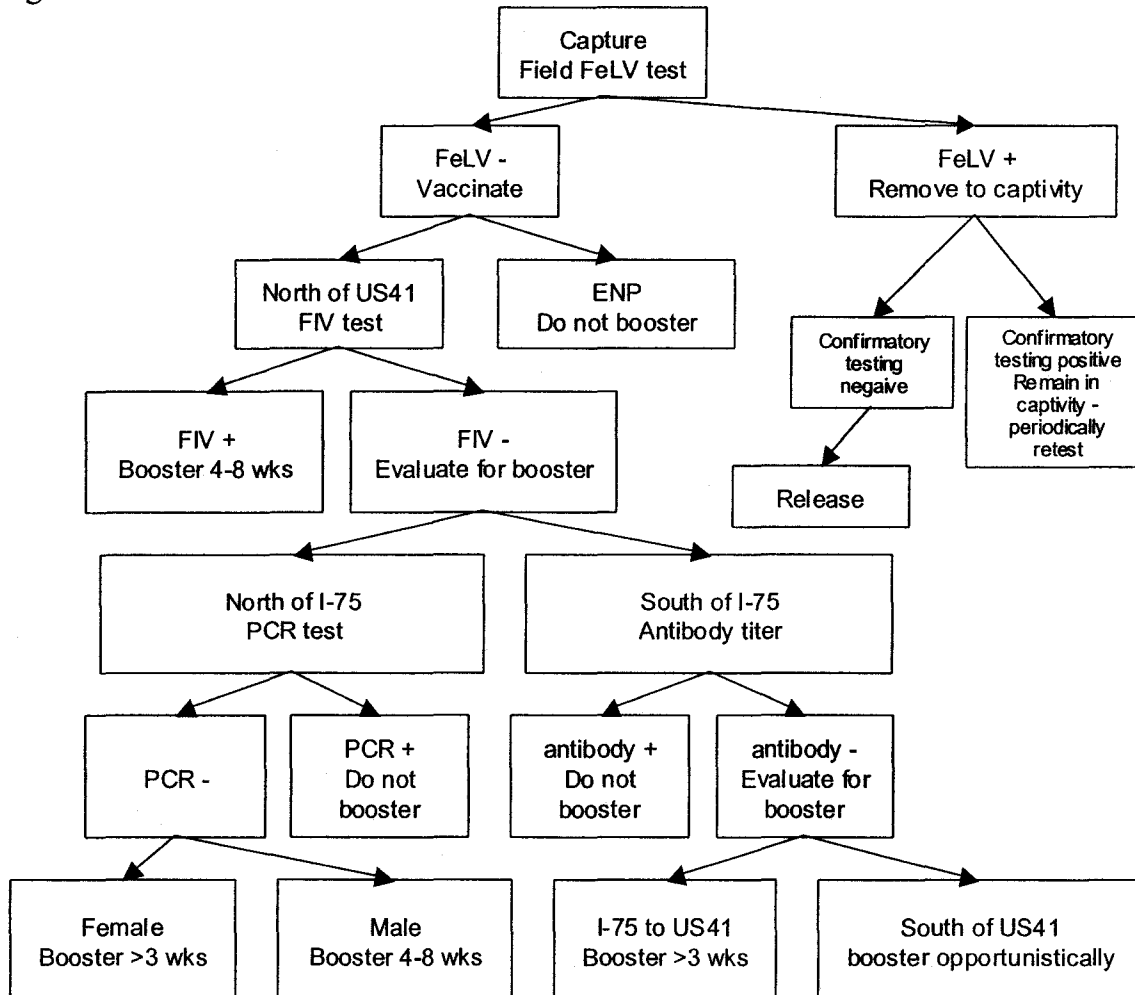
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Table 1. Summary of responses from advisory group concerning the removal of an infected male panther.

	Strongly advise removal	Undecided	Against removal
Wildlife Biologists	2	2	1
Wildlife Veterinarians	5	1	0
Virologists/domestic animal veterinarians	2	0	2
Zoo veterinarians	2	1	0
Total	11	5	3

Figure 1. Decision tree for vaccination and test-removal.



Feline Leukemia in Florida Panthers - Briefing Statement 10-28-2004

What is feline leukemia virus (FeLV)?

- Feline leukemia virus is a retrovirus of domestic cats.
- Only rarely reported in non-domestic felids; is not known to have become established in any free-ranging non-domestic felid (except European wildcat).
- Transmission is by direct contact – bite wounds, breeding, mutual grooming, or mother to offspring.
- Exposure to FeLV can result in 3 outcomes:
 - o 1) cats can clear the virus and remain permanently immune; these cats are not infectious after clearing the virus.
 - o 2) cats can retain latent virus and remain non-infectious and overtly healthy; theoretically, stress to the cat can cause a re-emergence of the virus and the panther becomes infectious.
 - o 3) cats can become persistently infected as evidenced by virus presence in bone marrow; these cats are infectious.
 - Persistent infections result in immunosuppression, cancer, and/or severe anemia.
 - Mortality rate is approximately 50%/yr.
- The disease is controlled in populations by vaccination and/or test-removal.
 - o Vaccination requires a booster at 4 wks and provides approximately 90% effective protection.
 - o Test-removal works synergistically with vaccination to eliminate the disease in closed populations.

FeLV in panthers

- FWC's Panther Team first detected FeLV in panthers in November 2002.
- A total of 5 panthers have been diagnosed, all of which are dead today.
- Currently, all known infected panthers resided in or adjacent to the Okaloacoochee Slough State Forest (OKS) in Hendry County (northwestern portion of panther range).
- No panthers are known to be infected today. All other captured or necropsied panthers have tested negative.
- As in cats, there is evidence that, following exposure, panthers can clear the virus, be latently infected, or be persistently infected.
- Preliminary results suggest that a greater than expected proportion of panthers become persistently infected.
- Time from infection to death also appears to be more rapid (<6 mo).

Current management of FeLV in panthers

- At capture a field test kit is used to test for FeLV.
- Panthers testing negative are vaccinated, followed by a booster in 4-10 wks.
- Vaccination has been the primary management tool to control the disease in panthers.
 - o As of 10/28/04, approximately 20% of the population has been vaccinated.
 - o Vaccinations have been concentrated in OKS and to the south to create a buffer of protected panthers between OKS and the core of the population.
 - o The vaccination goal is approximately 50% of the population.

Proposed addition of test-removal to management plan

- We recommend that captured panthers testing positive be immediately removed to captivity.
- Confirmation testing would be completed in 2-3 business days, panthers testing negative could be released.
- Persistently infected panthers would be held in captivity until they cleared the virus or succumbed to the disease.
 - o Panthers clearing the virus could eventually be released.
 - o Captivity would allow treatment of opportunistic infections associated with FeLV infection.
 - o Secondary benefits include better monitoring of the progression of disease for research purposes.
- Facilities are currently available to house approximately 5 infected panthers.
- We expect to capture 0-2 infected panthers this capture season.
- The NPS Big Cypress National Preserve has fielded a capture team and is following our vaccination protocol. They will coordinate with us for the removal to captivity of any panthers they capture that test positive.

The FWC capture team has consulted with virologists, epidemiologists and wildlife biologists about managing this outbreak of FeLV in panthers. The following are some of the issues raised and our discussion:

Removal of infected panthers would create a population sink that could place other panthers at risk as they occupy these vacancies.

Our removal of infected panthers would only accelerate the sink that would be created by disease progression. Removal of infected panthers ends the chain-of-transmission. A population sink represents only a theoretical risk while the presence of an infected panther represents a definite risk.

Do we have sufficient space at captive facilities for permanent placement of infected panthers?

We have identified space for up to 5 panthers at facilities that have partnered with FWC in holding panthers in the past. It is unlikely that we would encounter that many infected panthers during one capture season.

Removal of infected panthers would interfere with our investigation of the disease outbreak.

Florida panthers are one of the most endangered mammal populations in North America. Disease management takes precedence over experimentation, plus this is a non-native, exotic disease. Also, the disease is currently geographically restricted, facilitating our ability to eliminate the outbreak if we act early. Our vaccination program is already disrupting the course of FeLV infection in the population.

Removal of infected panthers may be unnecessary if they die before transmitting the virus.

Panthers do appear to die relatively quickly once they are persistently infected. However, we have seen an example of one male panther becoming infected during an aggressive encounter with another FeLV positive male. If the infected male had been

removed, no transmission to an uninfected panther would have occurred. In short, they appear to be living long enough to transmit the virus to the next panther.

Removal of infected panthers sets a precedent obligating us to remove all FeLV positive panthers we encounter in the future.

We are advocating an adaptive management approach to this disease outbreak. It is unlikely that we are going to encounter >5 FeLV positive panthers in any given year. Removal of infected panthers during the upcoming capture season coupled with vaccination of all captured panthers may very well eliminate further transmission and spread of FeLV.

Removal of infected panthers results in loss of genetic representation of these individuals.

Persistently infected panthers have a short life expectancy and their ability to reproduce is almost certainly compromised by the disease.

Feline leukemia virus (FeLV) in Florida panthers – 9/24/04 update.

Background:

Characteristics – Retrovirus of domestic cats similar to HIV although not as genetically variable. There are 3 subgroups: A, B, and C. Subgroup A is the most common and only transmissible form (in domestic cats). Subgroups B and C arise from recombination with endogenous FeLV (part of the domestic cat genome) or mutation.

Distribution – Distribution is worldwide with a prevalence of 1-33% (approximately 1-4% in feral cats). The virus is extremely rare in exotic felids with cases reported in: free-ranging – mountain lion (1), sand cat (1) European wildcat (10%); captive – cougar (1), leopard cat (1), clouded leopard (1), bobcat (1), cheetah (3).

Transmission – Transmitted by direct contact – especially bite wounds, also transmitted placentally or through nursing. Only about 20% of kittens born to persistently infected queens survive. Consumption of FeLV feral cats by panthers is a possible mode of transmission. Although now that it has jumped the species barrier, transmission is now probably panther to panther.

Signalment – Infection is more common in domestic cats <2 yr and slightly more common in males.

Progression and clinical signs – Most cats exposed do not develop viremia and disease, approximately 30% develop a transient viremia which resolves (but may be latent), while approximately 10-30% develop persistent infections. FeLV causes immunosuppression, anemia, and/or cancer in persistently infected cats. Following development of persistent infection, annual mortality rate is approximately 50-57%.

FeLV Diagnosis:

Elisa antigen – detects FeLV virus proteins in the blood. Is positive in persistently infected cats and can be briefly positive in transiently and latently infected cats. This test is performed annually on all panthers captured.

IFA – detects virus in neutrophils and platelets – presence indicates infection involves the bone marrow and thus has gone beyond the transient phase.

PCR – extremely sensitive test that detects viral genetic material in blood or other tissues. Is positive in persistently and latently infected cats, and briefly in transiently infected cats.

ELISA antibody – assesses the immune response to FeLV (i.e., detects exposure). Exposure does not necessarily imply that infection (virus) is present. Is positive in transiently and latently infected cats (and briefly in vaccinated cats) but is variable in persistently infected cats (indicating a reduced immune response to the virus).

Serum neutralization – panther serum containing FeLV antibodies is tested with culture to determine ability of individual panthers to clear infection.

FeLV in Florida panthers – results to date:

Free-ranging Florida panthers – Since 2002, five panthers have tested positive for FeLV ELISA antigen – all in OK Slough (northern portion of panther range). Of these, four were believed to be persistently infected while one was killed before persistent infection could be confirmed. All known positives have died – 3 due to what are believed to be FeLV-related diseases, 2 due to intraspecific aggression. Time from

diagnosis to death averaged 2 months, and in one panther (FP132), time from suspected exposure to death was 4 months.

Retrospective analysis of archived serum samples indicate significant exposure to FeLV beginning in the late 1990's and concentrated in the northern portion of panther range. Antibody titers and PCR indicate that some panthers can be exposed to the virus and recover. The virus appears to have a greater impact on panthers, although it is unknown whether this strain is more virulent and/or panthers are more susceptible. Nevertheless, a greater than expected proportion of panthers exposed have gone on to become persistently infected, the time from infection to death appears to be more rapid, and transmission appears to be easier. The latter is exemplified by the putative transmission of FeLV from FP123 to FP132 via a single bite wound. Susceptibility may be influenced by genetics. Four of five persistently infected panthers were believed to be pure. Co-infection with the puma lentivirus strain of FIV (a related retrovirus) may also increase susceptibility. Approximately 25% of free-ranging panthers are infected with FIV, however, 71% of panthers latently or persistently infected with FeLV are co-infected with FIV (although these results have yet to be confirmed).

Viral Characteristics – Genetic sequencing has not yet been completed, however, the virus so far appears to be subgroup A and similar to domestic cat strains. Viral culture has also been performed on samples from all infected panthers. Further studies on the pathogenicity of this strain are pending.

Source of infection – The source is unknown but is believed to be infected domestic cats; however, now that it has crossed the species barrier it appears to be spread from panther to panther. Four feral cats from the Big Cypress Seminole Indian Reservation have tested negative for FeLV. Testing, viral isolation, and sequencing will be performed on domestic cats sampled at animal shelters. Texas cougars released into south Florida were ELISA antibody and antigen negative during quarantine. Additionally, captive cougars at BC-SIR were ELISA antibody negative when handled FY1999-2000. Bobcats in OK Slough will be tested for FeLV this fiscal year.

Management:

Vaccination – Vaccination using Fel-O-Vax LV-K is safe and relatively effective (95-100% efficacy). Requires an initial inoculation followed by booster in 2-3 weeks. The booster would be accomplished by treeing and darting. Side effects may include cancer in 1-3/10,000 domestic cats vaccinated. The most significant risks are with capture and darting.

Vaccine trial – Three Texas cougars (TX105, 106, 108) and three Florida panthers (FP113, 114, 116) underwent a vaccine trial while in captivity at White Oak Plantation. The vaccine appears to be safe for use in pumas although a rise in antibody titers was inconsistent among individuals. Nevertheless, in domestic cats antibody titers are not indicative of vaccine efficacy, proper vaccination usually results in protection regardless of antibody response.

Vaccination of free-ranging panthers – Assuming a prevalence of 8%, it will be necessary to vaccinate 23-72% of free-ranging panthers to achieve control. Management for FeLV in the Florida panther population initially began with a vaccination program. On 20 August 2003, the three vaccinated and boosted orphaned kittens (FP113, FP114, FP116) that were part of the vaccine trial were released into the FPNWR (FP113, FP114)

and private lands east of Immokalee (FP116). Vaccination of free-ranging panthers began in November 2003. As of 1 September 2004, 21 free-ranging FeLV-negative panthers have received at least one inoculation; of these 11 have been boosted. Assuming a population size of 90, the largest percentage of the population that had received at least one inoculation was 23% (9 April to 28 July 2004); the largest percentage vaccinated and boosted was 12% (same time period). Positive PCR findings in FP100 and FP110 indicate latent infections and subsequent protection from further exposure. As such these panthers may be considered "boosted", and bring the total up to 14% considered effectively protected.

One vaccinated panther (FP132) was initially vaccinated approximately 2 days after exposure, boosted 1 month later, but nevertheless became persistently infected. Because exposure was known to have occurred before vaccination, FP132 was not considered vaccinated and is not included in the vaccination table. To date no other vaccinated panthers have become infected.

Capture/test/removal –Given the apparently increased susceptibility of panthers to FeLV, vaccination will likely be augmented with test-removal to control the disease (see attached recommendations for further information on test-removal).