PSITTACINE BEAK AND FEATHER DISEASE IN PARROT CONSERVATION

Conservation Challenges and Complexities

IUCN SSC Wild Parrot Specialist Group
Health and Welfare subgroup
2025

Wild Parrot Specialist Group

Part of IUCN SSC

Quick Links

Flow charts and Decision Trees

Welcome!

Welcome

The IUCN SSC Wild Parrot Specialist Group recognizes the potential threat and impact of Psittacine Beak and Feather Disease (PBFD) and its etiologic agent Beak and Feather Disease Virus (BFDV)/Psittacine circovirus on populations of wild parrots and their conservation around the globe. The WPaSG Health and Welfare subgroup created this document, not as the answer to all questions, but rather as a collection of suggestions and guidelines based on current science that may be useful for conservation planning. We fully acknowledge that PBFD provides uncertainty, contradictions and is constantly evolving and being transported between and among populations, and that every case involving wild parrots is a unique situation requiring specific analysis. Our hope is to de-mystify and offer options to the conservation community, especially to field biologists and technicians, veterinarians, investigators, law enforcement and policymakers.

We urge that any conservation planning for or in conjunction with wild parrots, seek expert consultation and formal wildlife disease risk analysis. Our concerns are for all involved: the wild populations; the birds that are in human care and potentially to be released, and the birds taken from the wild that will spend the rest of their lives in human care, and the humans that are tasked with the tremendous burdens of decision-making for them. We are deeply committed to maintaining top health in all wild Psittaciformes and securing the highest levels of health and well-being.

Our sincere hope is that this document will prove useful and supportive of successful planning and appropriate release to the wild—of this most treasured and threatened taxon.

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With Gratitude,

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Quick Guide: What to Look For with PFBD/BFDV

Suspect:

- "Sick bird syndrome" (a common early finding due to co-infections and immunosuppression)
- Fragile-appearing or broken primaries, secondaries and tail feathers with associated impaired flight
- Abrupt and excessive molting
- Feather loss around the eyes, ears, and neck
- Mild to severe overgrowth of the upper beak
- Folliculitis and inflammatory dermatitis in the areas of alopecia
- Feather dyscrasia in replacement plumage following the molt
- Thermal imaging shows "patchy" plumage with multiple thermal leakage
- UV exam of beak may show unusually strong reflectance

Likely to be positive:

- Known exposure to a positive population
- Birds from crowded, unhygienic conditions in close quarters within mixed populations of pet/breeder/ex-captive and wild caught birds
- Certain species in particular geographic locations
- Exposure to known risk species: Lovebirds, Rose-ringed parakeets, cockatoos, Australian species both wild-caught and captive/breeder/in-human-care

Quick Guide: What to Do before PFBD/BFDV

Having a wildlife-avian-experienced veterinarian on your team will be a vast help. They will be knowledgeable not just about health and disease and treatments/euthanasia, but also about the confusing laws, regulations, reporting, testing, notices and recommendations for your locale. Agricultural, wildlife, public health and multiple other government agencies will be involved.
You will need to find out:

- Who your veterinarian of choice is
- What agencies will be involved with response, management and mitigations of an outbreak in wild parrots?
- What regulations for the management of wildlife diseases and/or invasive species are in place?
- Is PBFD/BFDV found in wild parrots in your region?
- Has PBFD/BFDV been found in captive parrots in your region?
- Who conducts wild parrot surveillance in your species and region?
- Is testing available? What tests are available? What kind of samples are required?
- What are the plans for positive birds? Who makes decisions?
- Does infrastructure support acquisition and maintenance of testing supplies, collection of and storage of samples, shipping and permitting?
- What species are affected and what is their known susceptibility to PBFD/BFDV?
- Is there a safe and biosecure isolated facility available for housing potentially + birds?
- Are there plans for long-term care, personnel and funding in place?
- What do you do with deceased birds?

Quick Guide: What to Do with positive PFBD/BFDV

- Euthanasia may be the first choice if symptomatic birds are suffering and have multiple co-infections
- Positive or symptomatic birds may recover and do not require euthanasia if plans have been made for their long-term care and placement
- Symptomatic birds should be separated to simplify monitoring
- Each bird should be tested and re-tested with different testing modalities
- Diagnostics for co-infections should be thorough and treatment as appropriate (remember that + birds are immunocompromised and "normal" mild pathogens can be lethal and unexpected/novel infections are likely)
- Local wild populations should be sampled and monitored for PBFD/BFDV
- Transparency regarding PBFD/BFDV with potential recipients of + birds
- Release to the wild might be appropriate if the recipient wild population is known high prevalence + and monitored closely, and if the released birds can be routinely tested and monitored
- Stay mindful that + birds may or may not be shedding the virus, symptomatic birds may or may not be positive, asymptomatic birds may or may not be positive or shedding
- Maintain strict biosecurity: humans, equipment, vehicles, transport carriers, cages, cleaning equipment, clothing, shoes can all spread the virus. Frequently replace/disinfect areas of common use i.e. feeders, nestboxes.
- Maintain routine environmental testing on air filters, ventilation ducts, window screens, feather debris
- Biosecure waste, trash and reuse management.

Quick Guide: What NOT to Do with positive PFBD/BFDV

- Do not hold known positive birds in facilities that house other birds and wildlife
- Never hold ex-pet/breeder/unknown origin birds with wild parrots
- Birds in rehabilitation should be housed away from confiscations and veterinary facilities
- Never share staff between facilities that are in isolation
- Do not release + birds to the wild without specific and approved planning
- Do not integrate confiscated parrots into any captive situation without thorough and repeated testing for an array of pathogens including BFDV
- Do not euthanize every positive bird; positive or symptomatic birds may recover and do not require euthanasia if plans have been made for their long-term care and placement

DO NOT become a human fomite! (A giant object that can harbor and transmit infectious agents, such as bacteria, viruses, or parasites.)

Quiz: who has PBFD?

A 

B 

C 

D 

E 

F 

Answer: Yes! Maybe! No?

A. PBFD+Psittacosis+Giardiasis. B. positive PCR PBFD confiscation. C. positive PCR PBFD clinical. D. Nutritional + allogrooming. E. positive BFDV, - clinical F. Polyoma Virus

List of acronyms

BFDV-Beak and Feather Disease Virus
ELISA- Enzyme-Linked Immunosorbent Assay
IUCN-International Union for the Conservation of Nature
HA-Hemagglutination Assay
HI– Hemagglutination Inhibition
PBFD- Psittacine Beak and Feather Disease
PCR- Polymerase Chain Reaction
qPCR- Quantitative Polymerase Chain Reaction
SSC- Species Survival Commission
WpaSG- Wild Parrot Specialist Group

Introduction

Wild members of the Psittaciformes–parrots are in peril. They face many threats to survival in the wild, including disease. A frustrating, confusing and dangerous obstacle to conservation efforts across the globe is the disease complex known as Psittacine Beak and Feather Disease (PBFD), which is initiated by the circovirus known as Beak and Feather Disease Virus (BFDV). BFDV is the main culprit, but the disease itself is complicated rarely without co-infections and co-morbidities, environmental factors, and anthropogenic factors.

Our understanding of PBFD in the wild is often imprecise, incomplete and the disease can be unpredictable and variable. This state of knowledge gaps results in great difficulties preparing reliable conservation planning. The confusion leads to a kind of purgatory for birds who might be or have tested positive for BFDV, having no clear way to move forward into conservation efforts.

PBFD is contagious; often, but not always fatal; treatments are palliative and there is no cure. Vaccination is promising, but experimental at the time of this printing. The disease has been compared to silent immunosuppression and stigma of HIV/AIDS and the disfiguration, stigma and mysterious infectious pathways of leprosy in humans (however those diseases have appropriate treatments, vaccines, and even cures). It is named "beak and feather" because cutaneous structures involving keratin are often involved–beak, toenails and feathers, resulting in disfigurement and physical impairment; but it is primarily an immunosuppressive disease resulting in poor quality of life, decreased survivability, and death. Hence, consequences for inadvertent introduction by infected birds into a naive population are dire. Further complications include potential spillover to non-psittacines which has been documented in diverse avian taxa (MacColl et al. 2024, Amery-Gale 2017ne
i).

It is valuable to review the history of this enigmatic disease. PBFD was first observed by Edwin Ashby (1910, 1920) from clinical signs (more on that later) who described a flock of completely featherless red-rumped parrots (*Psephotus haematonotus*) in the Adelaide Hills of

South Australia. PBFD was formally named in the 1970s by Ross Perry after recognizing it as a common problem in Australian psittacines. The spread of wild-caught birds through the international pet trade from the 1840s onwards facilitated the disease's global expansion. The circovirus responsible for PBFD was difficult to study in its early days due to difficulties in culturing it in the lab, but research has since identified it as a significant threat to both wild and captive bird populations worldwide.

Both legal and illegal import of wild-caught parrots into the pet trade, especially in the northern hemisphere, boomed in the 1970s-1990s. Active contagion assures infections within transportation and housing at the points of capture and departure, holding facilities, quarantine stations, pet warehousing and pet stores, and commercial breeding facilities. PBFD has spread without barriers or controls in many breeding facilities, especially in Asian countries, and in wild parrots exposed to introduced and escaped captives and it is now found on a global scale. Conservation planning is deeply affected and in need of careful guidelines.

PBFD can appear clinically identical to many other health issues (see Figure 1 below), and the converse is true as well; and all complications may be present simultaneously and expressing and exacerbating each other (see Differential Diagnoses below).

Figure 1: Sinus infection or PBFD? Or both?

Clinical presentation of PBFD varies between different taxa, between individuals, stage of molt, between life stages, between viral genotypes, genomics of host, virus(es) and all active pathogens. Combining comorbidities associated with wildfire smoke, environmental contaminants and toxins, deterioration of water and forage quality and intense anthropogenic stress further negatively impacts immune system function.

Immune integrity is compromised by multiple pathogens of captivity having various ingress routes to wild populations and captive birds intended for release: associated with overcrowding, poor nutrition, poor husbandry, physiological and mental distress, social disruptions, alienation from place in the ecosystem.

Vulnerability of populations, reproduction and individuals is further amplified by interaction of environmental factors or chemicals with immunomodulators and immunoregulators with viral infections.

PBFD/BFDV, Conservation and Redlisting

How does PBFD/BFDV affect conservation planning?

The uncertainty, unpredictability and unknowns surrounding this complex disease entity blur precise conservation planning and decision-making. There is a need for a uniform approach, yet each situation will require careful tailoring. Queries (such as "Can we release this bird?" "Should this bird be euthanized?" "Is this bird healthy?" "Does our population have PBFD?") important to the basic foundations of disease planning, decision-making, preparation, management and mitigation may have no solid answers. Wildlife disease analysts need to make certain that the planning team and all stakeholders understand, and to suggest flexibility be built-in to the planning as the situation becomes knowable or more fluid.

How does PBFD/BFDV affect the Redlisting Assessment and subsequent vulnerability status?

Redlisting criteria 8.1-8.5 from IUCN - CMP Unified Classification of Direct Threats support information for IUCN Red List Assessments of the impact of pathogens or disease processes that have impacted, are impacting, or may impact the status of the taxon being assessed. The impacts of PBFD may not be easily recognized nor be clear-cut yet threaten an entire population (whether of Least Concern or Critically Endangered) with extinction. Providing clear evidence-based reasoning urging uplisting may be challenging.

Presence of this pathogen is of great concern for conservation planning and to the negative impact on populations. Of 78 species where BFDV has been detected in wild or captive birds, 64.1 % (50 species) are categorized as Least Concern; 9.0 % are Near Threatened, and over a quarter are classified as Threatened, Endangered, and Critically Endangered. A declining population was observed in over 60 % of BFDV affected host species (Fogell et al. 2016).

Basics

Why is PBFD so important?

In the wild, PBFD may affect a single individual, a single population, a single geographical area, an entire taxon. Presence and prevalence are difficult to establish, including within populations in short term captive care (such as law enforcement holding, quarantine, wildlife rehabilitation, veterinary premises). Infected birds may or may not test positive on various testing modalities, may or may not appear healthy, may or may not be carriers; and all those levels can fluctuate over the life span of an individual and within a flock or population. Coinfections and co-morbidities further obscure interpretation. Assessment of survivability and fitness may be difficult, as impact of active, latent or recovered infections is both difficult to determine and predict.

There is also mounting evidence that BFDV associated with PBFD may not be confined to psittaciform birds, posing additional threat of spillover to other taxa (Amery-Gale et al. 2017, Circella et al. 2014).

A looming threat of immense magnitude originates from trade in psittacine birds. The uniformed and haphazard mixing of wild and pet birds within facilities; mixing of species from distant geographic locales; dismal husbandry in trafficking, legal pet trade and captivity in general (Ghizoni 2023); lack of true quarantine, testing and planning following parrot confiscations; unintentional and intentional releases by both the public and traffickers and careless release by rescues and law enforcement; knowingly "bird-laundering" (CITES 2025) into aviculture with subsequent entry to legal pet trade; have manufactured PBFD into a global concern for ANY conservation planning for parrots. All situations from ex- and in-situ breeding, wildlife rehabilitation and release, veterinary, re-locations, translocations, and re-patriations are at risk.

Why is PBFD/BFDV so difficult?

Only some scenarios of viral (BFDV) infection lead to disease (PBFD), and these are described below.

Pathogen flow for BFDV is highly complex and often not well-known or not well documented (Figure 2).

BFDV Pathogen Flow

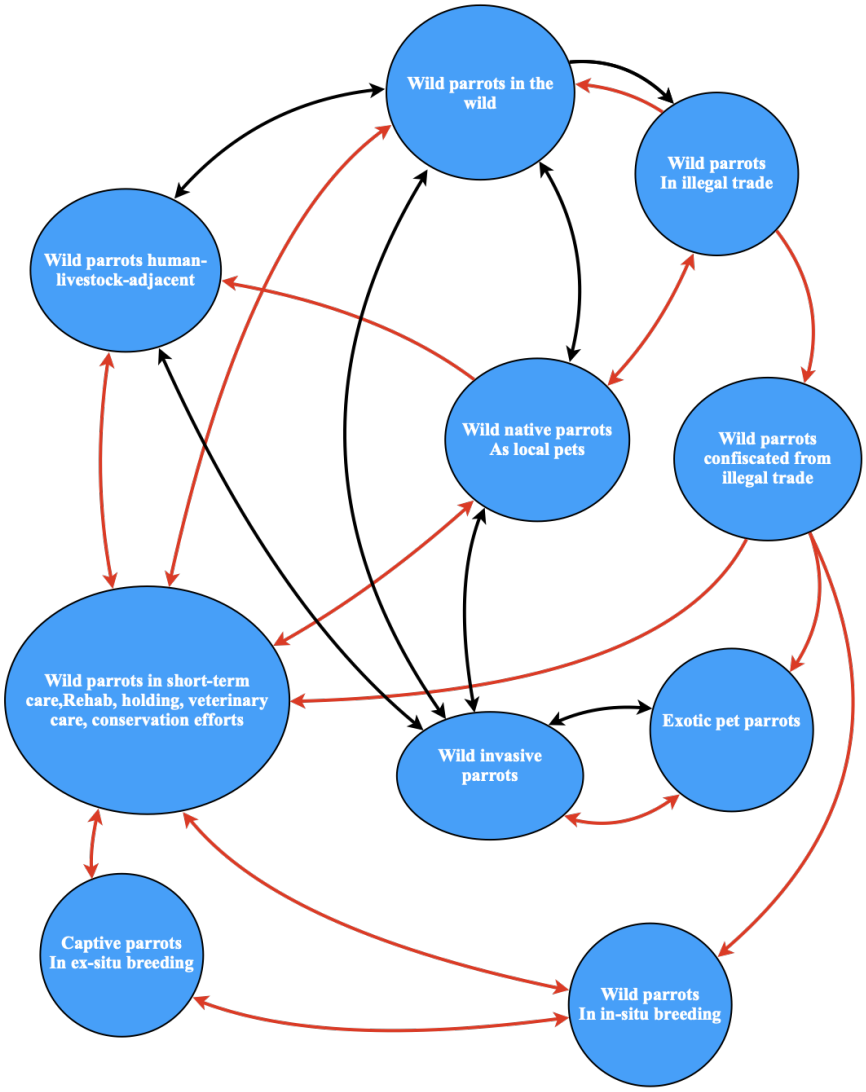


Figure 2. This flow chart illustrates simplified pathogen flow for Beak and Feather Disease Virus, showing human-assisted pathways as red arrows and parrot-based pathways in black. In reality, many other pathways exist including vectors, vertebrate fomites, environmental impacts.

BFDV infection and disease dynamics

(courtesy of Andrew Peters, Charles Sturt University)

Beak and feather disease virus (BFDV) is a psitt-enveloped single-stranded DNA circovirus with two principal encoding genes - rep, which encodes replicase involved in viral circular genome replication; and cap, which encodes the viral capsid protein. BFDV capsid is the primary antigenic component of the virus (i.e. it is the part recognized by a bird's adaptive immune system).

BFDV is widespread in natural populations of parrots in Australasia, where it is thought to have originated. Current BFDV genetic data supports the existence of two distinct lineages of the virus - one (the 'lorikeet' lineage) that infects and circulates primarily in the lorikeets, and one (the 'cockatoo' lineage) that infects and circulates primarily in other parrots. A notable exception to this is that, based on current data, it appears that New World parrots are both relatively resistant to infection with at least the cockatoo lineage of BFDV and also do not have endemic circulating BFDV in wild populations. African and Asian parrot taxa appear to have mixed susceptibility and, while there isn't evidence that BFDV circulates endemically in wild parrots outside Australasia, there have been reports of epizootic infections.

The route of BFDV infection in parrots is thought to be primarily oral, though cloacal exposure has also been proposed in young birds. BFDV is able to be shed from infected birds in feathers and feather dander (thought to be a major route of shedding and environmental contamination), feces and likely other body fluids (e.g. mucus). There is some uncertainty about the role of hematophagous and other parasites in the transmission of BFDV, however, if this does occur, it is unlikely to be a significant route of transmission in most parrot populations. After entering the environment, BFDV can remain for extended periods.

The vast majority of BFDV infections in parrots are not accompanied by significant clinical disease. To understand when and how disease occurs, some understanding of the immunological response to infection is needed. In healthy, adult parrots (of most species), BFDV infection

following oral exposure triggers an adaptive humoral (antibody) immune response. This takes some time (i.e. weeks) to develop following the commencement of infection, and during this time the virus replicates in the gut, then organs such as the spleen and possibly liver, and finally in tissues like growing feathers. Replication in surface tissues (gut and feathers) takes time and typically leads to low level viral shedding (which can be detected quantitatively using hemagglutination or qPCR). This phase of viral infection is accompanied by a viraemia (BFDV is present, and is detectable by PCR, in the blood). An immunocompetent parrot typically (with some species exceptions), will mount a strong antibody response to the infection and this will enable BFDV to be cleared from the body. If disease occurs in these scenarios, it is likely to be mild and is followed by full recovery. Often such cases are detected incidentally during testing of populations, with no indications of active infection. Occasionally, feathers growing at the time of infection will become deformed (dystrophic) or discolored, and these will persist until the next molt (even though active infection has ended). The scenario just described can be thought of as the normal course of infection in the vast majority of parrots. Please refer to Figure 3 below.

Disease caused by BFDV, known as 'Psittacine Beak and Feather Disease' (PBFD), presents in three main scenarios identified through genetic and immunological testing over the past thirty years. Understanding these scenarios, their diagnostic differences, and related immune responses is essential for effective management of BFDV in parrots and assessing vaccination strategies.

Disease scenario 1: Acute infection

This scenario can best be understood as a 'normal' infection as described above, except that the immune response is either not effective enough, or quick enough, or is overwhelmed, so that the virus causes disease and, sometimes, death. The immune system recognizes the viral infection, but viral amplification is so rapid, or the frontline innate immune response so impaired, that the virus causes widespread damage to body tissues leading to disease and/or death before an adaptive immune response fully develops. A number of

Figure 11.factors can create this scenario, including especially age (young birds appear particularly susceptible), immunogenetic competency (e.g. impaired immune function due to loss of genetic diversity), co-infections with other viruses or bacteria, poor nutrition or environmental conditions, and likely exposure dose (how much virus a bird is initially exposed to). In wild populations with high levels of circulating, endemic BFDV, young birds are likely mostly protected from infection by antibodies against BFDV, which are acquired through the egg from the hen. The absence of endemic circulating BFDV in a population likely makes young birds more susceptible to infection. In such circumstances, when BFDV enters and is transmitted through the population as an epizootic (a wave of infection), young birds that are infected may show a range of disease severity from mild signs through to death, shaped by the various factors as mentioned above.

Disease scenario 2: Latent infection

Latent infection appears to only occur in some species of parrots. It is particularly well-recognized in some lorikeet species (e.g. *Trichoglossus moluccanus*), but likely occurs in many others, and appears also to be able to emerge in species that historically have not exhibited latent infection. The latter is of great concern in the management of critically endangered species. In this scenario, following initial infection there is an antibody immune response, but it is weak. Current evidence is that such birds cycle through waves of viral release and amplification (detectable in blood by PCR), though at relatively low levels, followed by increased antibody production (detectable as higher antibody titers in blood), which suppresses but doesn't clear viral infection. The virus remains latent in the body (likely in bone marrow, spleen and possibly liver and other organs) until antibody titers decrease over time and then, possibly in response to some trigger (e.g. stress), is reactivated. Very little is known about the clinical significance of latent infection, apart from the observation of occasional feather dystrophy or discoloring. Disease appears to be typically mild, though because it is recurrent and unable to be cleared there are likely to be circumstances in which it causes more significant signs and potentially death. Possibly, however, latent infection has subclinical effects including energetic costs, immune suppression,

increased risk of co-infection and so on, and such effects could potentially be significant in already compromised populations. In my opinion (AP), determining *if* and *how* latent infection affects parrots is one of the most pressing matters relating to BFDV in threatened species management.

Disease scenario 3: Persistent infection

PBFD was first described in persistently infected birds, though this disease scenario is relatively rare, is unusual amongst viral infections (though other examples do exist) and appears restricted to only some parrot taxa, notably the cockatoos (in the broad sense). It is definitely the most distinctive presentation of BFDV infection and is widely recognized as such. In this scenario, a bird is infected (almost certainly while young, in the nest) and fails to mount an antibody immune response. The virus gradually continues to amplify in the body (detectable in blood by PCR), and infects surface tissues (e.g. feathers) where it causes prodigious shedding (detectable by hemagglutination or qPCR). These birds never develop an antibody titer against BFDV. The virus continues to ravage the body, unchecked by the adaptive immune system, and signs progress over months to years, including feather dystrophy and loss, beak and claw dystrophy, diarrhea, immune suppression, secondary infection and, invariably, death. The cause of this scenario remains undetermined but can be hypothesized with some confidence. The adaptive immune system of vertebrates is powerful but carefully calibrated so that it does not respond to background stimuli (e.g. the commensal microbiome of the gut or skin). This calibration occurs throughout life, but an important phase occurs early in life in which immune cells that target background stimuli (including the body itself) are destroyed. This loss of adaptive immunity against certain stimuli (antigens) is called anergy. It is highly likely that parrots with persistent (NOT latent) infection are anergic to BFDV, that is, they are incapable of mounting an adaptive immune response to the virus.

Diagnostic testing can be used to differentiate these three disease scenarios. The two key tests needed (in combination with clinical signs) are direct viral detection (e.g. PCR) and antibody detection (e.g.

hemagglutination inhibition (HI), iELISA) in blood. Additionally, quantitative assays (e.g. qPCR, hemagglutination (HA)) can be used to assess viral shedding (Table 1).

Table 1. Disease scenarios

Disease scenario	Signs	Blood PCR	Antibody titer	Viral shedding
Acute infection	Mild feather lesions, acute death	Positive	Absent (if dead) to high (if recovered)	Absent to moderate
Latent infection	Mild feather lesions	Intermittent (weak) positive	Intermittent low	Intermittent low
Persistent infection	Severe feather lesions, progressive to eventual death	Positive	Absent	High

BFDV infection and immune response

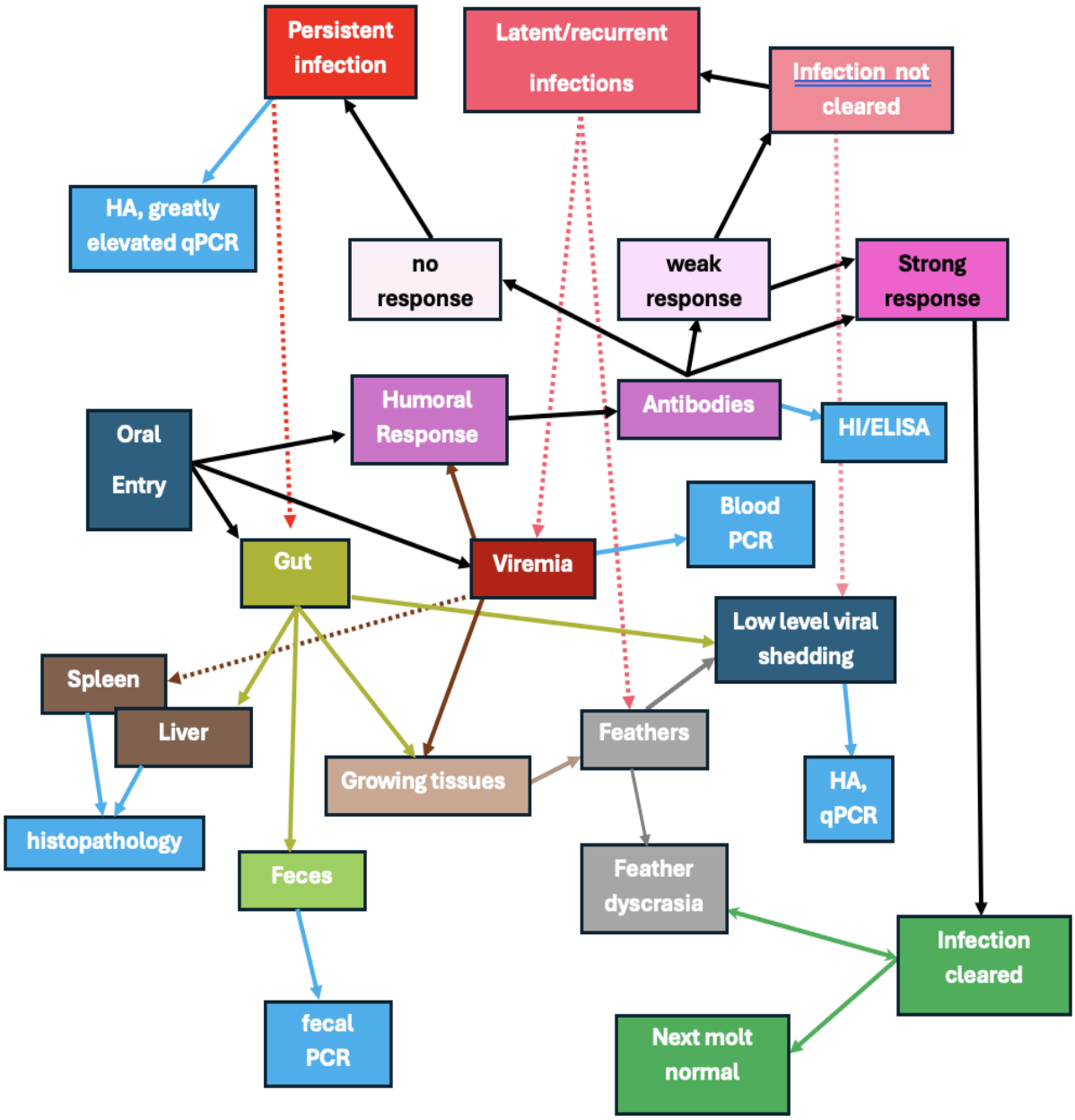


Figure 3. This flow chart illustrates PBFD/BFDV infection and immune response. Blue boxes are testing modalities. Red to pink indicate immune responses. Gi entry and shedding are light green. Brown and grey are tissues. Bright green is cleared of infection.

Differential Diagnoses

See the excellent overviews in Miesle, J. (2018), Psittacine Beak And Feather Disease: An Overview, and Olivarez et al. 2025.

Note: Not all visually suspect parrots have PBFD.

A diagnosis of PBFD cannot be made based solely on external appearance or feather examination (Blanch-Lazaro et al.2024). Feather dystrophy can be caused by any condition which disrupts the blood supply to the developing feather. If feather loss is primarily confined to the body and not the head, it is most probably due to one of the above causes. If the feathers on the head, face and crest are missing, it is likely PBFD. **Only** DNA/genetic/molecular testing (PCRs and other modalities) will definitively identify BFDV.

Similar clinical evaluations result from:

- Polyoma virus, which produces feather loss in a pattern similar to the BFD circovirus
- Adenovirus, known for affecting the tissue linings of the beak and oral cavity, respiratory tract, urinary tract, upper and lower intestines, and the eyes
- Trauma: for example, collisions, burns, electric shock injury
- Excessive preening and allopreening (birds preening each other) which can result in damage to head and neck feathers
- Bacterial and fungal infections, including folliculitis and sinus infections
- Metabolic and endocrine diseases such as hypothyroidism which causes excessive molt, lack of feather regrowth and pigment changes
- Liver diseases, which cause narrowing of the feathers and color changes
- Poor nutrition, which also causes feathering abnormalities, fragility, excessive molt, and color changes

- Chronically sick birds will present with poor feathering which might be mistaken for PBFD.
- Septicemia, other viremia, fungal infections
- Some drug reactions, particularly to penicillins and cephalosporins and photosensitivity.

Surveillance in the wild

Needs and Gaps-how widespread is it?

Data is sparse, surveillance is deeply limited, and the quick answer is "we do not know". Testing birds in human care is straightforward and could answer at least the presence and prevalence of BFDV within wildlife rehabilitation, conservation facilities, holding/quarantine and confiscated birds. This effort should commence immediately.
Finding answers concerning wild populations is a bit more difficult, but not impossible. "Boots-on-the-ground" (or in the trees) need assistance with testing supplies, safe storage, mailing/shipping, and CITES permitting allowing access to psittacine experienced laboratory testing. These relatively simple logistics are achievable. Providing ample access to FTA cards and appropriate sampling swabs would allow long-term storage while waiting for permits.

Is it already out there? What damage has it done on a population level?

What is the PBFD situation in the wild? In most cases, again, the quick answer is "we do not know". What are the risks and consequences of releasing positive birds to the wild? Can acceptable levels of risk be defined? To assess risks related to the Redlist and vulnerability to extinction, population information is essential. This data void for PBFD is a serious detriment to accurate assessment and potential changes in listing.

Testing caveats

Testing is important especially to the individual bird in human care. Costs for simple PCRs might be absorbable for a few birds in preparation for release at rehabilitation facilities, or in care following confiscation. However, prudent conservation reintroductions require that the receiving population have reliable surveillance and birds intended for release have careful repeated screenings with multiple and expensive testing modalities. Few organizations can meet these criteria and can bear the financial burden; and few agencies monitor PBFD in wild populations.

Testing should be performed by experienced laboratories where possible and repeat testing is always advised. As mentioned above, latent infections can be difficult to determine, i.e., the same sample from the same bird can test positive in one PCR run and -negative in another. Commercial veterinary testing labs can be inconsistent. Viral sequencing of positive samples is always advised but many commercial labs do not do so and it is expensive and plagued with time delay. A limiting factor for tests and reliability of results can be attributed to the availability of good PBFD-positive reference samples.

Portable PCR machines can be useful (MiniPCR or Bentolab for example) but can also be temperamental in field conditions with limited access to power. These must always be used by people experienced at performing PCR because things can and do go wrong and being able to troubleshoot is essential. Obtaining relevant reagents can be difficult or impossible in some countries.

Until there is an inexpensive and easy way to evaluate immune status in birds, the "healthy-looking" positive-testing birds should best be assumed to be immunocompromised and their level of fitness possibly impaired. And here it is an important reminder that prevalence in a population is NOT a good predictor of the impact of that virus on the population health.

Stigma

Tests can result in more than positive-negative-uncertain answers. Impact on human interpretation can affect emotional and ethical considerations. The uncertainty can be intellectually draining and lead to hasty and inadequate planning and decisions. There may be pressure from authorities or organizations to euthanize symptomatic or positive-testing birds and a reluctance to invest funding into repeated health checks, co-infection control and treatment, immune support, and multiple testing modalities; and especially in acquiring the long-term time, personnel and financial support. There may be even more pressure to ignore or euthanize Least Concern and more common species (where funding is rarely available for health/disease in wild populations) when these might prove to be the most useful for study and eventual "herd immunity".

Thinking of PFBD as a hybrid of human leprosy and HIV/AIDS may be a valid comparison, and its stigma extends to life-long care in sanctuaries or ex-situ conservation. The "out-of-sight-out-of-mind" attitude may not support health or welfare for individual birds nor for the human caregivers, leading to inappropriate or unnecessary euthanasia that may be harmful to population immunity evolution. Both HIV/AIDS and leprosy stigmas were fueled by fear, the unknowns and uncertainties, and lack of factual material. Both diseases became known and manageable, and the victims returned to non-shunned, productive members of society.

Regardless of Redlisting status, evolutionary, immunological, genetic and ecological value, wild psittacines in human care may truly have no place to go. As with human diseases, better understanding and filling knowledge gaps will point to a more suitable future.

Consequences

Consequences of decision-making need to be thoroughly examined. The complexity of PBFD as a disease entity involving immune response (Martens et al. 2021), and latent/dormant states demands scrutiny. Entire species could be at risk. Huge numbers of healthy-but-positive survivors of wildlife trafficking might be put to death for little reason.

Facilities could be contaminated for life and never be safe for naive individuals…increasing the potential exposure and release of PBFD into pristine populations.

Positive consequences are important, for example: releasing healthy but positive birds that bolster both population numbers and immunity; establishment of life-long sanctuaries for the ”we do not know” birds as genetic insurance; removing the ”leper-colony-stigma” through testing, repeat testing vaccinations and treatment and mitigation.

Testing modalities

Improvements and new technology are ongoing and evolving. We recommend a PCR method with universal BFDV primers as a quick, easy, and consistent diagnostic test for BFDV detection, as described in Buyse et al. 2022. Duplicate or even triplicate testing if funding permits, i.e. on the same blood sample at the same time with different extractions of DNA can assist verification.

DNA concentrations should be determined and standardized.

As of August 2025, the following are recommended testing modalities.

Current testing regimen available:

- Molecular: PCR/qPCR targeting the replicase associated gene (Rep) or Capsid gene (Cap). In endemic situations, conventional PCR only does not always convey clinically relevant information, interpretation coupled with viral load (qPCR) and serological data is more reliable.
- Serology: Hemagglutination Inhibition (HI) assay for detection of anti-BFDV antibody in avian blood is the current Gold standard, is commercially available in Charles Sturt University, Australia. A commercial ELISA is currently under development.
- Immunohistochemistry: On tissue samples, anti BFDV antigen.
- Sequencing: On positive samples, Sanger amplicon sequencing and whole genome sequencing is well established.
- Biopsy and histopathology: often used to rule-out other differentials.

Testing issues: Remote locales

- Which tests are best with no funding, limited skills and personnel
- Local facilities/labs have ability for the various testing modalities for BFDV?
- Export, transportation and shipping availability and costs to appropriate labs
- CITES issues: the challenge of CITES permits form laboratory samples and the huge impact of those on timeliness for meaningful action on the findings
- Portable PCRs, appropriate primers and other portable testing tests availability and usefulness when electricity and refrigeration and storage are not available
- Costs of all the above are well outside most care facilities

Testing issues: Knowledge Gaps

- Lack of circovirus surveillance in wild
- Lack of circovirus surveillance in confiscations
- Lack of circovirus surveillance as a routine part of action plans*
- Unknown status of BFDV vaccine availability and efficacy: are vaccines on the horizon?
- Are there suitable and appropriate facilities for placement of healthy positive-testing birds?
- No centralized database
- Data from authorities is lacking or difficult
- Wild population monitoring
- FUNDING

What do the tests mean?

Endemically infected flocks show high antibody titers and low disease prevalence, leading to self-sustaining cycles of infection and the buildup of flock immunity. This was seen in the Mauritius Parakeet, where population growth was observed despite the presence of BFDV (Fogell et al. 2021). Sometimes birds recover and gain immunity (Ritchie 2024).

Positive

- Some birds infected with the virus test positive never show clinical signs
- A positive result from a bird with no feather dystrophy may mean either that the bird is a carrier or a recent exposure. In this case, it is best to isolate the bird and re-test it in 90 days. The second sample should be collected by venipuncture
- Retest all PBFD positive birds 60-90 days after the initial testing was completed.
- If the second sample remains positive, the bird should be considered a carrier and will be permanently infected.
- Birds that test positive twice, yet show no signs, should be considered to be infected and may exhibit clinical signs later or during times of duress.
- Controlling the disease involves testing susceptible birds and isolating or culling any that test positive twice, 90 days apart, even if they have no lesions of PBFD.
- Other birds which test positive may develop an immune response sufficient to fight off the infection and may test negative after 30-90 days.
- Some young birds will initially test positive and should be retested 30 days later. If the bird still tests positive, then there may be a lowering of the circulating virus; however, eventually these birds may test negative and remain clinically normal for the rest of their lives

Negative

- A negative blood test may not mean that the bird is free of disease, it may be in an undetectable or early state of infection.
- Inappropriate or faulty sample collection/storage may result in false negative. Samples for PCRs may be stored indefinitely if they are protected from the elements and contamination; most blood tests require refrigeration and immediate shipment to a lab–a challenge in tropical latitudes.
- If the bird has a competent immune system, the virus will be eliminated, and the negative results will be valid.

Management and testing recommendations

What the heck do we do? It is confusing

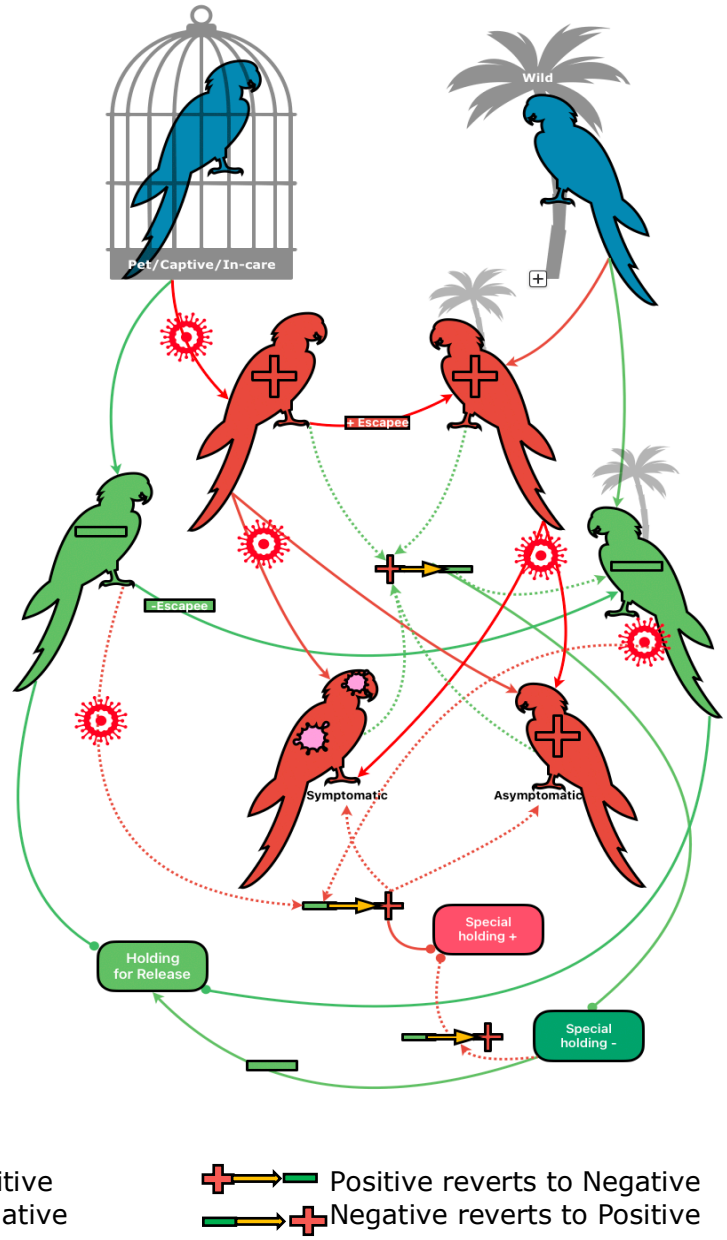


Figure 4. Decision tree illustrating positive and negative PCR results from parrots in human care and free-flying wild parrots. Green lines indicate pathways for confirmed negative birds and solid red lines indicate pathways for positive birds. Red dotted lines show directions where negative bird convert to positive.

Management and on-going/repeated PBFD testing of wild parrots

Will conservation efforts spread PBFD? Conservation planning should consider management to reduce the spread or impact on wild populations. Urgent decisions may need to be made quickly and in the face of substantial uncertainty. Unacceptable risks to populations or species (extinction, catastrophic decline with subsequent uplisting) may result from making the wrong choice. Monitoring of a population and ongoing evaluation of consequences is essential (Fogell et al. 2019).

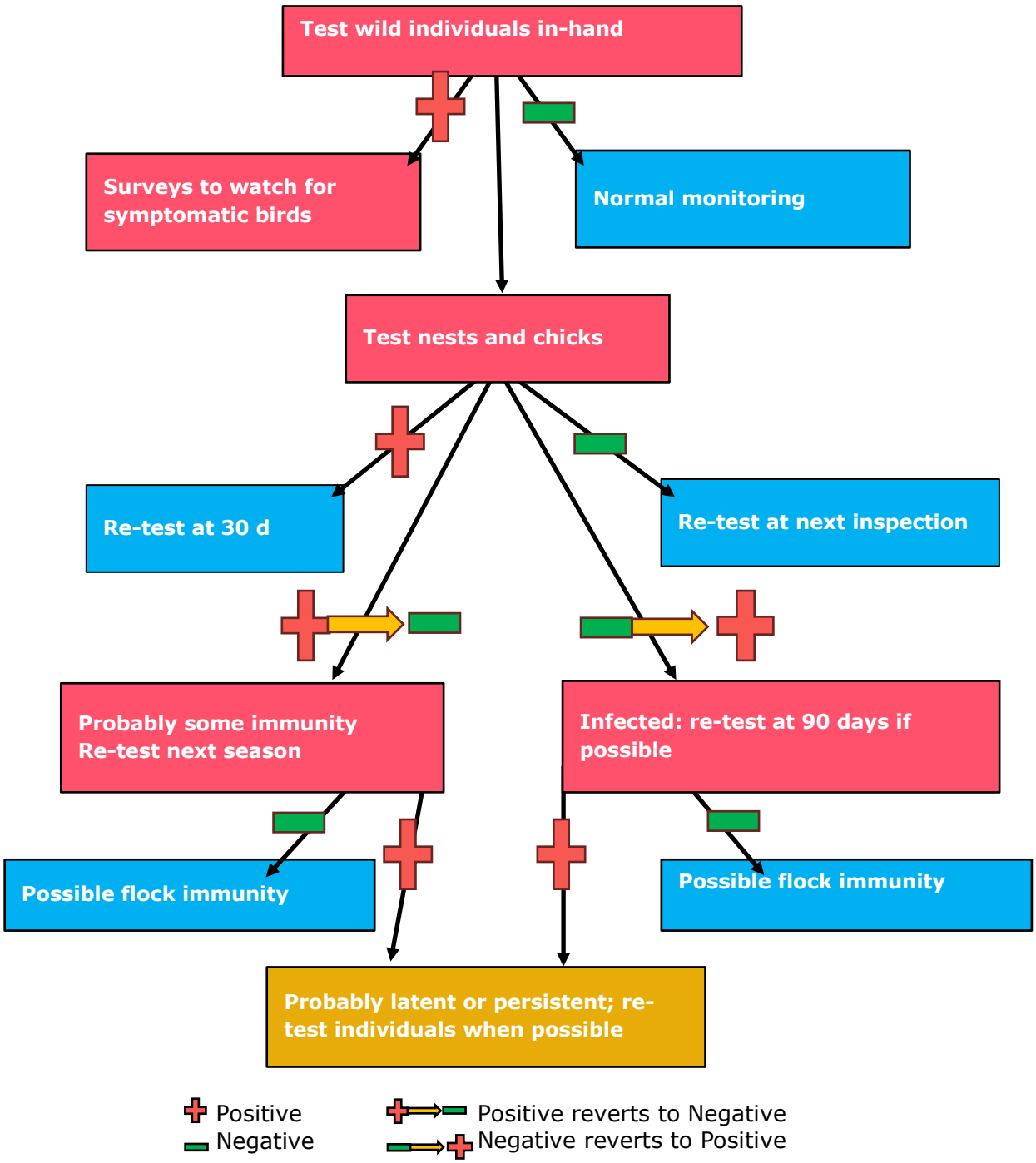
Relatively non-invasive testing, such as monitoring supplemental feeding stations and nest boxes (Tollington et al. 2018) may allow evaluation of effects on population fitness and functions.

Can observing wild birds indicate PBFD and the severity of impact in the population? A significant inverse correlation was found between viral load and overall physical condition including presence and severity of clinical signs of PBFD in Cape parrots, indicating that clinical signs are useful to diagnose relative severity of BFDV infections in wild populations. A viral load ratio less than 10-3 is a useful cutoff value for assessing birds as being disease-free (Regnard et al. 2015).

Suggested monitoring of wild parts is illustrated in the Figure 5 Managing and Monitoring PBFD in wild populations Flowchart below. Every population and case is unique, and monitoring should be tailored accordingly.

Figure 5.

Flowchart for Management and monitoring PBFD in wild parrots



Management and repeated testing of confiscated birds

Confiscated birds survive little-studied levels of stress and physical injury during and after smuggling. Following seizure, they may be housed in facilities used for other domestic species, poultry, pet parrots, breeding birds, private homes, offices, or other low welfare situations. The opportunity for exposure to pathogens of poultry, pathogens of captivity, pathogens of poverty, pathogens of mammals and reptiles is likely. Wild parrots are known to acquire PBFD from these types of situations when exposed to non-native exotic psittacines in pet trade (Romero-Vidal et al. 2024). They most certainly will be exposed to parasites and microbial pathogens not encountered in the wild and further amplified by stress and captivity. Thorough health evaluation and pathogen analysis is warranted.

Quarantine, possibly including intensive care and nursing, with repeated testing for PBFD and multiple co-infections is recommended for no less than 6 months, and likely longer.

Evaluation parameters at admission and routinely thereafter

- Weight (g), overall condition, beak, cere, feathers, blotches, down feathers, feather dust
- Photos from all angles including axillae (Figure 6)
- Maintain accurate and timely records
- Repeat at regularly scheduled intervals, being mindful of the stress it may induce

Figure 6.

External Examination: The physical examination should be thorough, and documentary photographs should explore all angles: A. external resting appearance from a distance; B. primaries, these show evidence of severe secondary infection of the follicles; C. ventral and D. dorsal surfaces. Photo credit: Lauren Byrd and Ebony Forest

Testing Regimen

Repeated testing is valuable,but is a team decision. Every situation is unique and deserves careful planning in advance. Multiple, unexpected and novel pathogens are likely. See Figure 8 Flowchart for Managing and repeated testing of confiscated birds below.

Medical management

Test as necessary but be mindful that capture and testing procedures may induce stress-related immunosuppression. It is a delicate balance between monitoring and making the situation worse.

- Routine clinical blood panels
- Regularly scheduled fecal analyses of individuals and flocks
- Co-infections: regularly scheduled and repeat testing as necessary
- Medical management for co-infections and immunosuppression
- Regularly scheduled premise testing for PBFD

Coinfections: recommended testing modalities

- Zoonotic diseases of importance to the current locale, or origin, or in associated seizures.
- *Chlamydophila sp*. is especially common, and testing is required for quarantine and isolation, many modalities are available (Figure 7).
- Bacterial: staining techniques, aerobic and anaerobic culture and antibiotic sensitivity, microbiome analyses (e.g., MiDog), pathogen screening including most mammalian enterics and anaerobes (including *Campylobacter sp.* and *Vibro sp*.). Note: normal commensals and opportunistic species can be highly pathogenic with immunocompromised PFBD-positive birds.
- Viral: PRC screening at minimum for common diseases of captive parrots, poultry, humans and livestock

- Mycotic: swabs and PCRs for Avian Gastric Yeast *Macrorhabdus, Candida sp.* and other yeasts, *Aspergillus sp*., fungal screening (Note: normal commensals and opportunistic species can be highly pathogenic with immunocompromised PFBD-positive birds)
- Parasitic direct smears, stained smears, fecal float, PCR and other screening tests. Possibilities include broad-host organisms such as *Cryptosporidium sp.*, *Giardia sp.,* various coccidia, *Balantidium sp*., lice, mites, fleas and mosquitoes may be potential vectors.

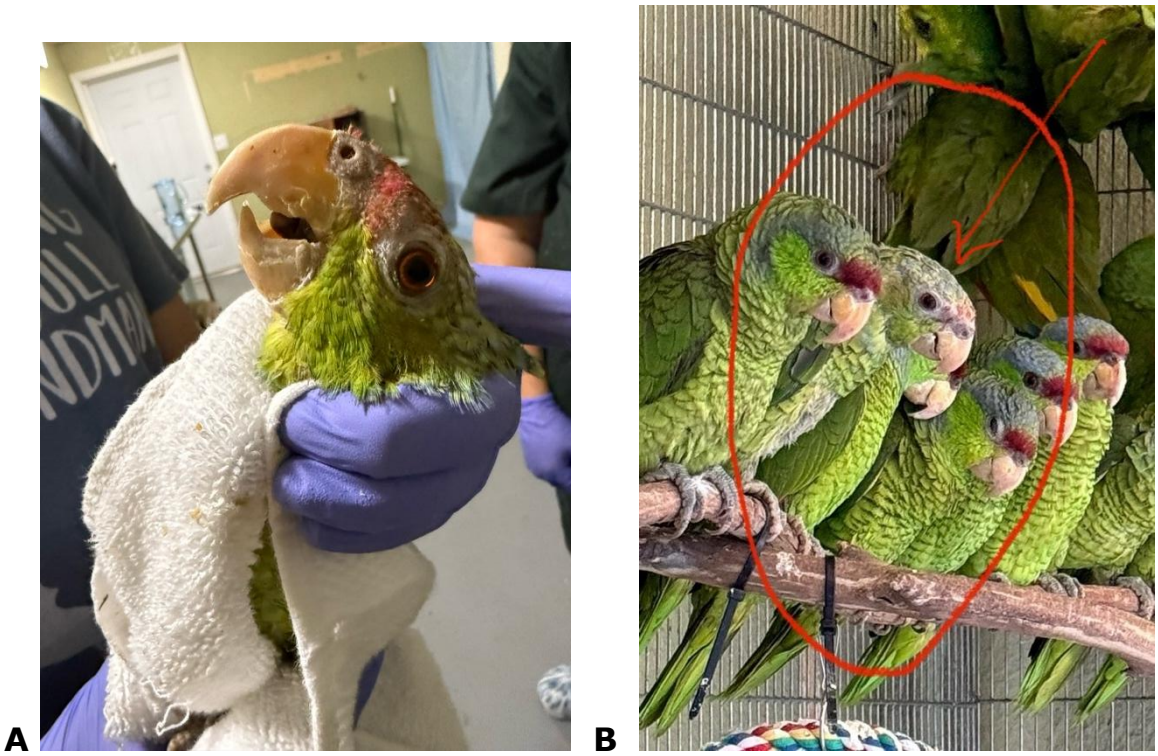
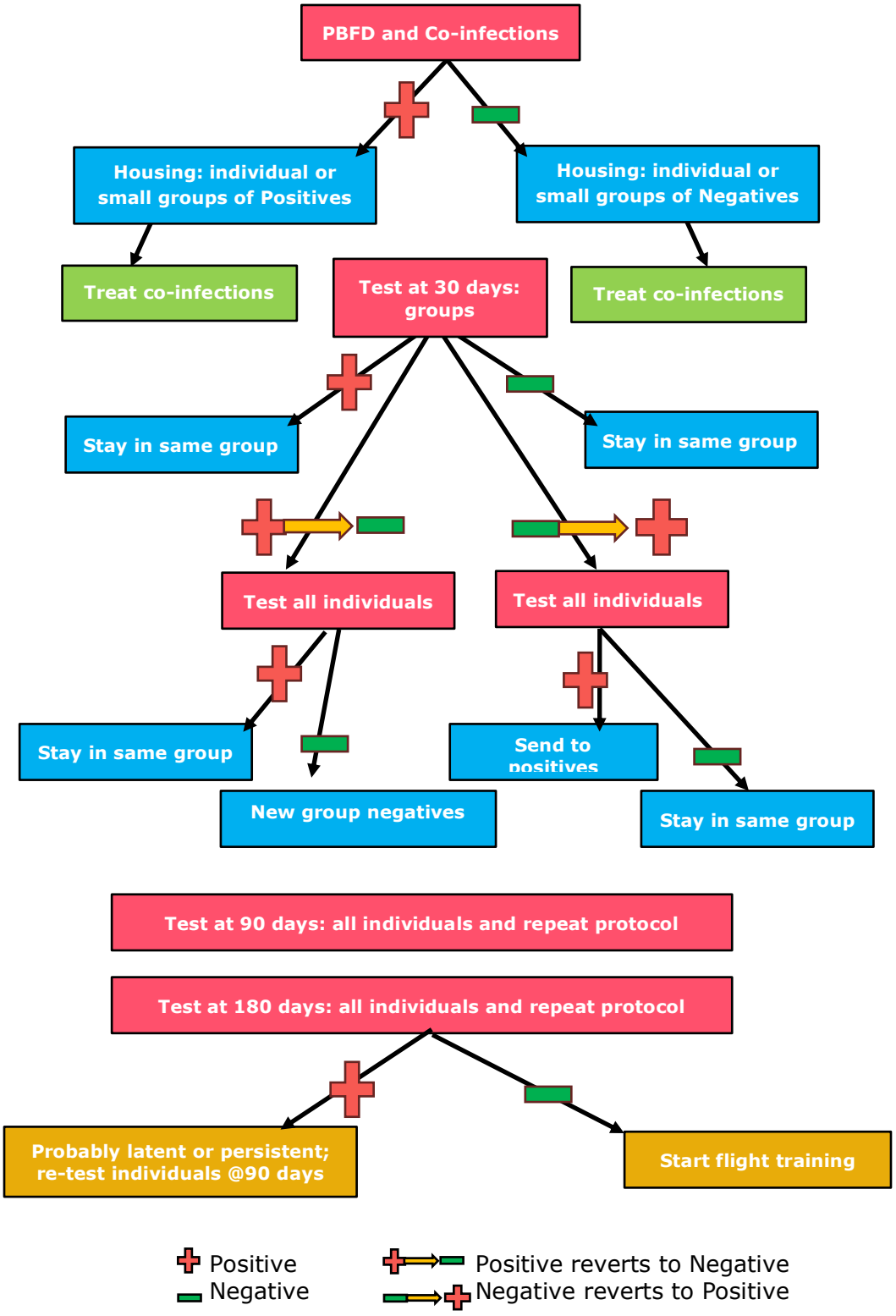


Figure 7.

Coinfections: A. This Lilac-crowned parrot (Amazona finschi) has PCR positive for PBFD, and concurrent co-infections of Chlamydophila psittacii, upper respiratory pathogens, Cryptosporidium sp., and multiple mammalian enteric pathogenic bacteria. B. The arrow indicates the same bird in very early recovery stage. The bird was successfully treated for co-infections, with repeated PBFD PCR results negative, and with improved husbandry regained a new molt with normal-appearing plumage. Photo credit: Pat Latas

Figure 8:

Flowchart for management and repeated testing of confiscated birds



Management and on-going/repeated testing of long term in-human-care: medium acceptable risk

Evaluation parameters at admission and routinely thereafter

- Weight (g), overall condition, beak, cere, feathers, blotches, down feathers, feather dust
- Photos from all angles including axillae
- Maintain accurate and timely records
- Repeat at regularly scheduled intervals, being mindful of the stress it may induce

See Figure 9 below for an example that substantiates the correlation between appearance and testing as observed in the field (Regnard et al. 2015).

Figure 9.

External appearance of PBFD in an early-acute PCR+ BFDV infection. Photo credit: Pat Latas

Testing Regimen

Every long-term care situation is unique and deserves careful planning in advance. See Figure 10 Flowchart for Long Term In-human-care below.

Medical management

Quarantine with repeated testing is recommended for no less than 6 months, and possibly longer, possibly including intensive care and nursing (Morales et al. 2021).

Tests should be planned as necessary being mindful that capture and testing procedures may induce stress-related immunosuppression. It is a delicate balance between monitoring and making the situation worse.

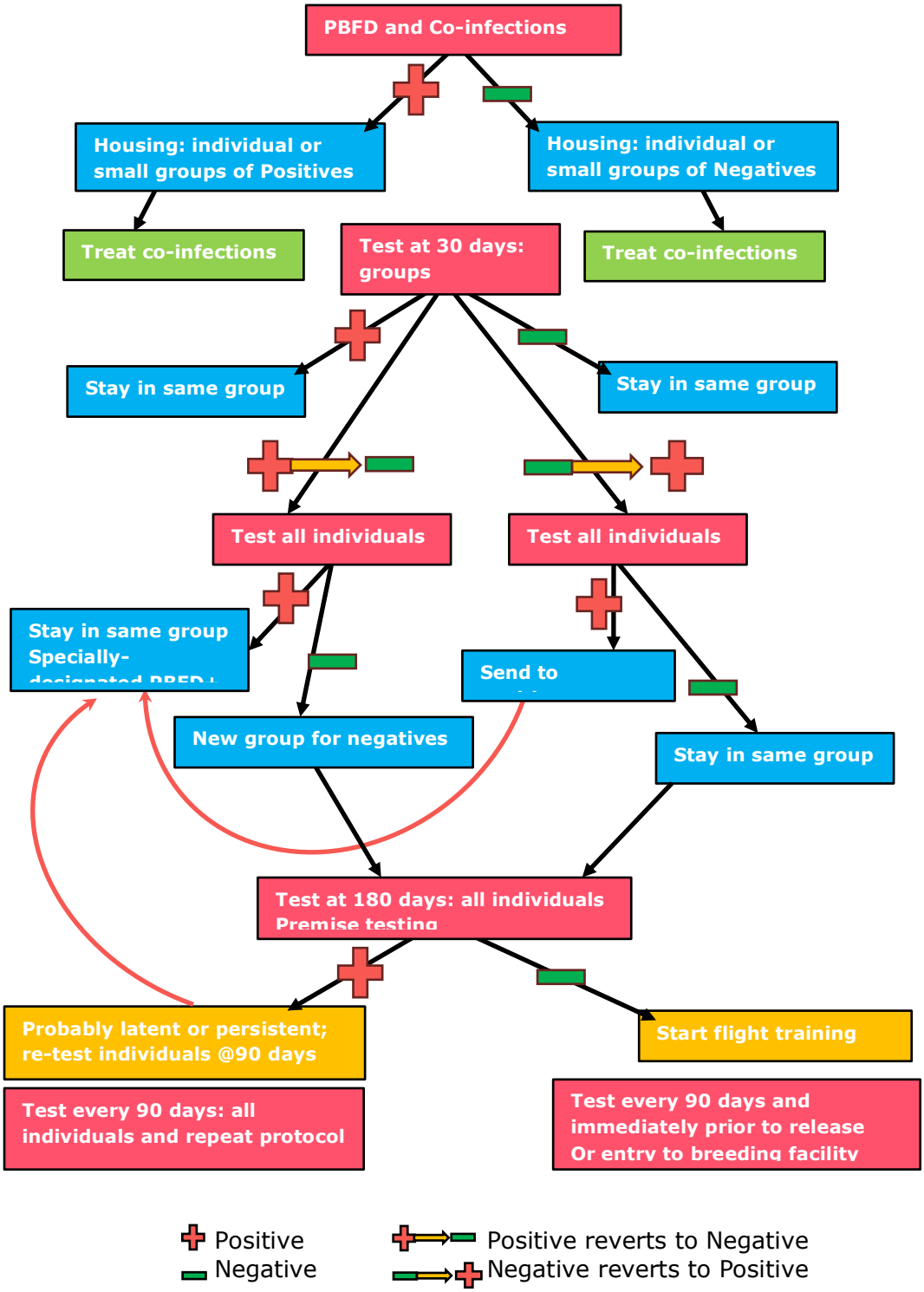
- Routine clinical blood panels
- Regularly scheduled fecal analyses of individuals and flocks
- Co-infections: regularly scheduled and repeat testing as necessary
- Medical management for co-infections and immunosuppression

Regularly scheduled premise testing for PBFD

- Confiscation temporary holding facilities (agency-based)
- Veterinary facilities
- In-situ Holding or Conservation Breeding facilities
- In-situ Rehabilitation for release
- Ex-situ Rehabilitation for release
- Ex-situ Holding or Conservation Breeding facilities

Figure 10.

Flowchart for Long Term In-human-care



Prevention and Mitigation

How can we prevent psittacine circovirus from entering populations? As a well-known phenomenon, prevention is magnitudes simpler (and less expensive in funding, time and people) than treatment and mitigation.

Proper and thorough veterinary physical examination

A detailed physical examination of birds by a veterinarian with experience in both parrots and wildlife undergoing rehabilitation and entry to conservation efforts is an initial measure to prevent PBFD from spreading to wild populations. In addition, gathering a comprehensive history of interactions among wild, confiscated, or captive native species and exotic species can help assess the risk of viral transmission.

Isolation

Confiscated birds are an easy entry point for infection. Preventing their re-entry into the wild only after isolation and careful testing and re-testing of individuals can decrease the possible release of PBFD into the wild. Assuming the holding facility is disinfected and free of environmental viral contamination.

Wildlife rehabilitation is another soft entry point, even if the birds are from local flocks known to be negative. Unfortunately, injured or orphaned parrots are often kept by the public, the authorities, and even veterinarians, in situations that expose the wild birds to pets/confiscated/sick birds that are infectious. Isolation and testing can prevent or diminish the risks to wild birds.

The public and authorities should be educated so that unwanted, confiscated, injured and orphaned parrots are both protected and isolated and safe re-entry is a planned process. Situations with countless uncertainties and few resources may opt to wait out the course of the disease, and survivors be released with or without testing.

Control of the Pet Trade

"Wait and see"

"Do nothing" can be a valid choice, depending on the clarification of accepted risks and consequences and a full understanding to the virology and disease ecology of the situation. In species that have PBFD in the wild, it may be acceptable to release positive, asymptomatic birds; or to wait for symptomatic birds to recover and be released–if the viral sequencing matches. Introduction of a new variant into a population with a different genetic background by induce rapid viral evolutions with catastrophic impact.

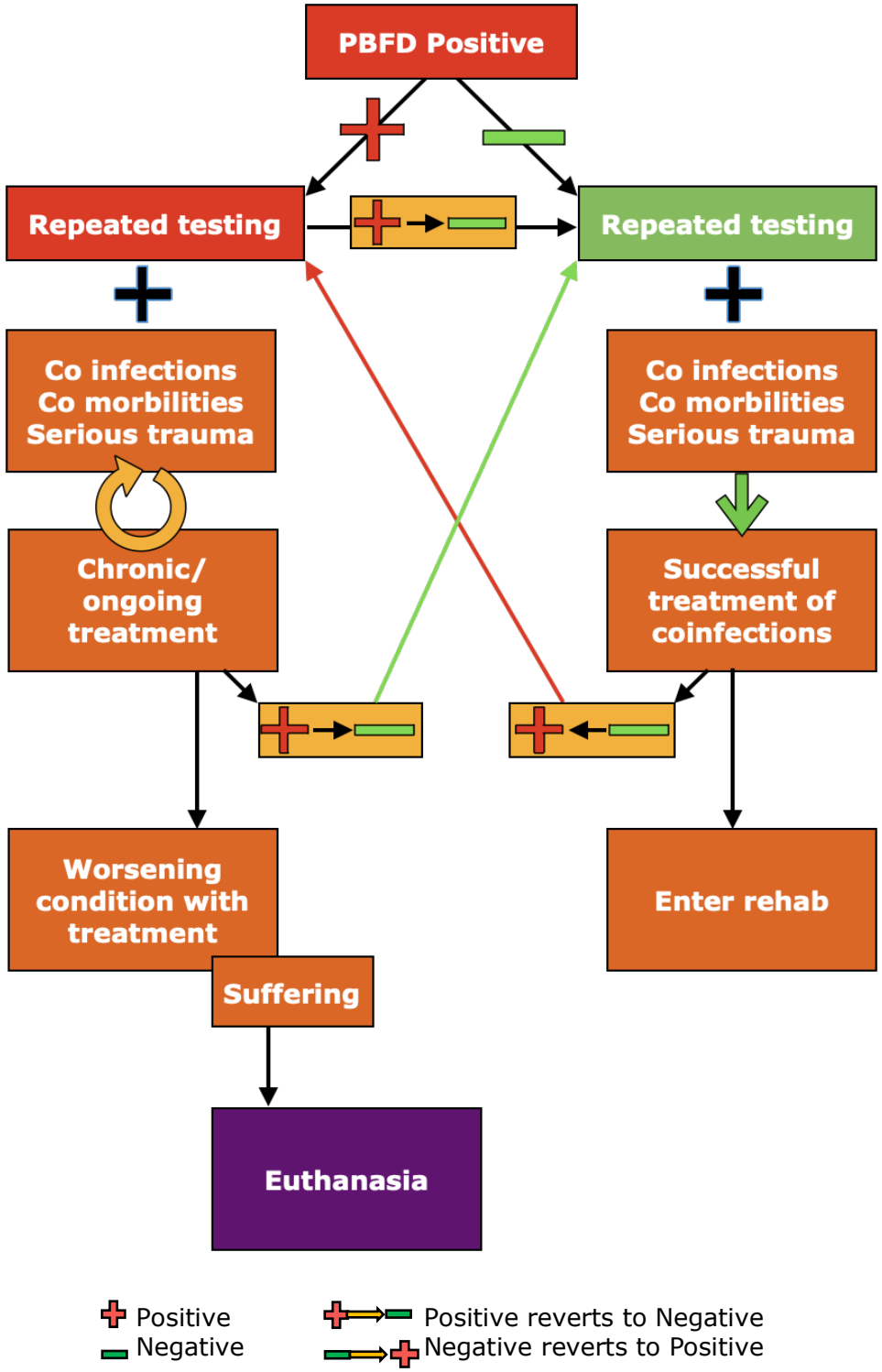
Time itself may be the best preventative measure, by simply waiting out the course of the disease with full health support and excellent husbandry for the duration.

Euthanasia considerations

A reminder is due here that some countries do not allow euthanasia or have very limited resources for humane options. When to euthanize is a team decision, based on evidence and welfare evaluation. Please see the decision tree for Figure 11 Euthanasia and PBFD below. If a bird is suffering with no hope of adequate treatment (therein lies an uncertainty), euthanasia is justified. Very hard decisions may be necessary especially when there is no infrastructure to support long-term care or extensive testing. Conservation value, even if incorrect, may be the over-riding limitation. Rarity, Redlist status, and monetary value may enter the process. Few or no options for placement may be the deciding factors. See also Depopulation below.

Figure 11.

PBFD and Euthanasia



Vaccines???

There is a recombinantly expressed VLP based vaccine currently being developed by avian circovirus research team based in Charles Sturt University, Australia (Das et al. 2019). This vaccine has been trialed on at least 12 species of Psittacine birds and demonstrated promising response in raising delectable antibody levels and also showed positive response in reducing the viral load (DNA copies) in infected birds. A promising plant-protein-based vaccine is being developed (Mulando et al. 2025). However, current funding obstacles are hindering the registration of the vaccine and in-depth research required to generate more data. Import and the use of the vaccine will likely entail detailed regulations and/or prohibition of use in the wild in the target countries.

Quarantine guidelines for Positive Populations in the Wild

Geographical quarantine for the species

Great care should be taken planning reintroduction or translocations. Geographical quarantine may need to be observed to prevent accidental release of positive birds into negative regions, and negative birds into positive populations. Entire species may inhabit known geographical areas where wild birds are known to be positive, yet the species remains negative. To reiterate, monitoring of PBFD status in wild populations is essential to planning.

Handling in the field

Research and monitoring activities may be a primary entry point for BFDV.

Humans

- Humans are giant fomites: objects that can harbor and transmit infectious agents, such as bacteria, viruses, or parasites. Fomites act as vehicles for the spread of pathogens. They can become

contaminated when touched by an infected individual or when they encounter contaminated surfaces or fluids.

- Field work must be monitored carefully so that human investigators do not unknowingly bring in pathogens or spread them
- Keeping in mind that pathogens are happy to travel in any direction, minimal PPE can prevent humans from spreading their own germs everywhere. Investigators should wear exam gloves, proper masks, eye protection when handling birds and nesting material. All should be discarded and new PPE donned between sites/nests/ birds.
- Footwear: all debris should be removed from footwear and thorough cleaning of the soles with soap and water. Footwear-safe disinfectants then applied (Rescue or similar hydrogen peroxide-based products) are usually safer for the environment as well.
- Clothing: if changing clothes is not possible between sampling or nest sites, inexpensive exam overalls are not unbearably hot and at least prevent major cross-contamination. A new one is required at each sample site.
- Do not work with parrots if you are sick. They are susceptible to many human pathogens, which often are fatal in psittacines. Be personally clean and aware of your potential as a fomite.

Equipment

Disinfection of field equipment is essential, but very difficult, inconvenient, time-consuming and expensive. It may be more cost effective to have location-specific multiple sets of equipment.

- All clothing, footwear, gloves, ropes, containers and so forth must be thoroughly cleaned and disinfected between sampling sites and after every use.
- Bags, instruments, biometric equipment, medical equipment, restraint items, and all tools and gear need to be cleaned and disinfected between use; for example, bags for chicks should not be used from multiple nests, rather clean ones used for each nest.
- Large equipment, ropes and vehicles need special attention to prevent pathogens from travelling between sites.

- It is easy to forget that your phone, tablet, pens and paper are happy to collect pathogens and spread them.
- Measurement equipment, scales, banding tools, marking items, need to be kept clean and disinfected between sites. Hydrogen-peroxide based disinfectants (such as Rescue) in a spray are relatively non-toxic and useful for a wide range of pathogens. If possible, disinfectants should be protected from direct sunlight and excessive heat, in an ice cooler if that is possible.
- Nets and capture items: nets are notorious for transmitting pox viruses, but they are very efficient at transferring other pathogens as well. Wash and disinfect the nets and handles after each use.
- Work gloves for climbing may represent significant risk if they are not disinfected after every use. Disposable gloves can be worn underneath the climbing glove, if it is possible to remove the outer gloves while working at the nest.
- Crates, bags, carriers, boxes, and other containment
- Cloth bags should only be used once, or for several chicks from the same nest. Always use clean ones for the next group. The same goes for any other containment items.
- If birds are being held for a short time or if chicks need feeding, all food and water must be clean, sanitary and wholesome and all utensils and bowls thoroughly cleaned in soap and water and disinfected.
- One of the best ways to spread infectious pathogens is vehicle tires. Vehicles need to be kept clean inside and out and tires disinfected prior to driving to a new site.
- Thoroughly clean and disinfect ropes, harnesses and other climbing gear between sampling sites and after every use–which also protects the spread of plant pathogens as well. Soaking in the appropriate disinfectant and dilution that does not harm the equipment read the instructions carefully) works best. Link to disinfectants here.

- Nests and roosts: entry of pristine nests and roosts by contagious disease is catastrophic. Be aware of all your personnel and equipment before working with susceptible sites.

Plan for reintroductions --TBA

See also Release/relocation/translocation reintroduction guidelines

What is Acceptable risk

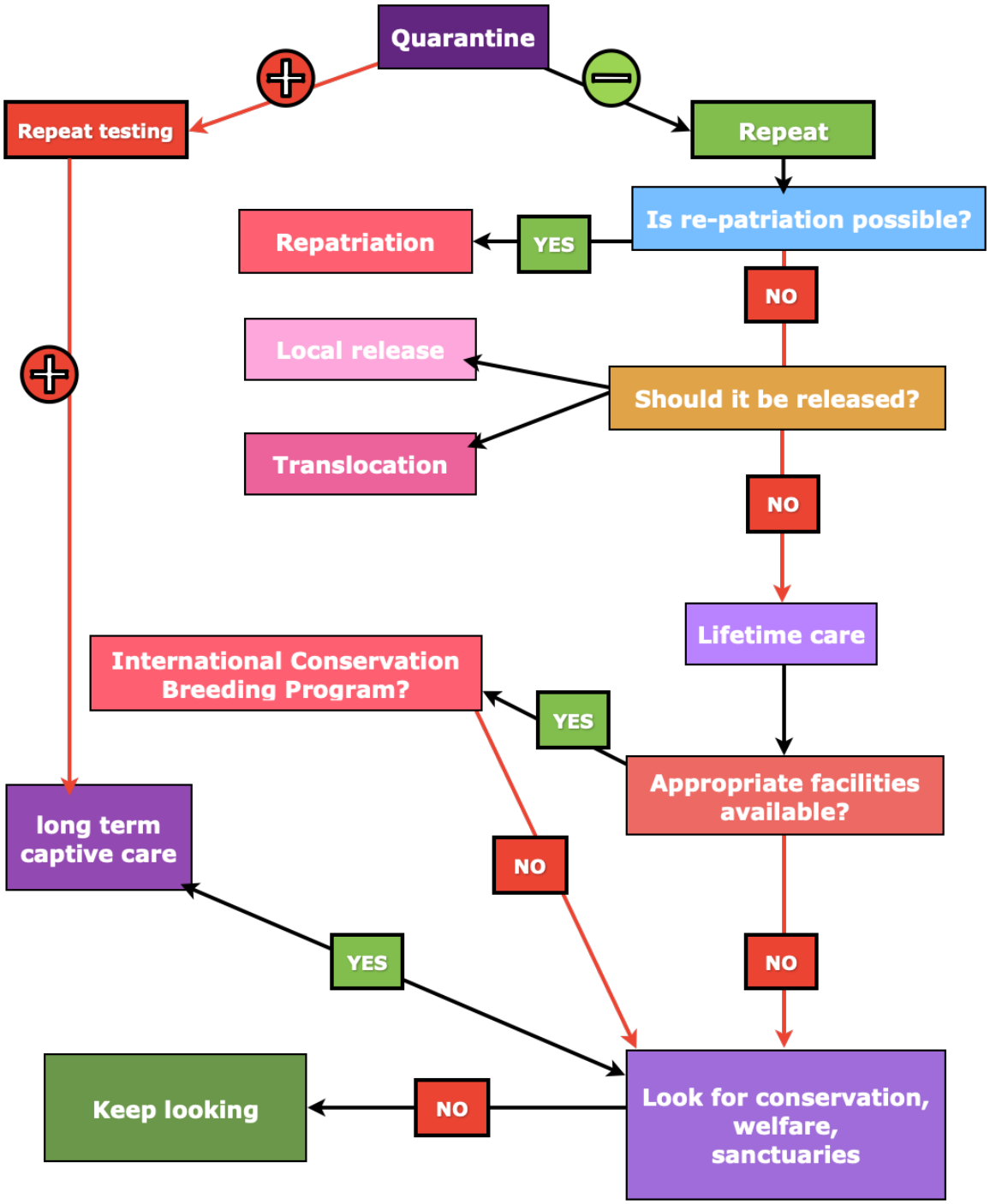
Placement or Care Options and decision-making

The uncertainty of almost every aspect of PBFD produces an enigma. Although it is known that birds exhibiting external signs of infection can return to normal plumage and health, there are latent and shedder states that make decisions very difficult. In addition, the stigma of positive tests–birds may be inappropriately euthanized, removed from the population, not included in conservation efforts and be refused placement in facilities– may inhibit factual test results and data over time. Facilities or conservation planners may be reluctant to admit sero-converted and negative BFDV testing regimens. Admittedly, there are no 100% guaranties of zero risk. This state of affairs must be acknowledged and met with solid solutions. Conservation planners will need to define the level of risk that is acceptable for PBFD entering the population of concern.

Currently there are very few adequate facilities that can offer long-term or life-long care to PBFD positive but healthy birds, or negative birds from PBFD infected populations. Zoos, ex- and in-situ breeding facilities and sanctuaries are understandably reluctant to take on these birds. Until this shortage is addressed, the decision tree below might be helpful, but the current situation is dire and wasteful of live birds which may be physical, reproductive and genetic insurance. Again, an honest assessment of the level of acceptable risk may allow more placement opportunities. Please refer to the decision tree Figure 12, Where the heck do they go? for suggestions.

Figure 12.

What should we do with positive birds?



Release/relocation/translocation reintroduction guidelines

Assuming details for health checks, testing, monitoring, thorough welfare assessment (such as the Five Domains, Mellor et al. 2020) and other parameters will be addressed by a conservation action plan, routine release/relocation/reintroduction guidelines are standard. An abundance of caution is required for birds rescued from trafficking with immunosuppression and possible other stressful states.

The IUCN SSC Conservation Translocations Specialist Group is a valuable resource for consultations and guidelines.

The major populations which deserve scrutiny are:

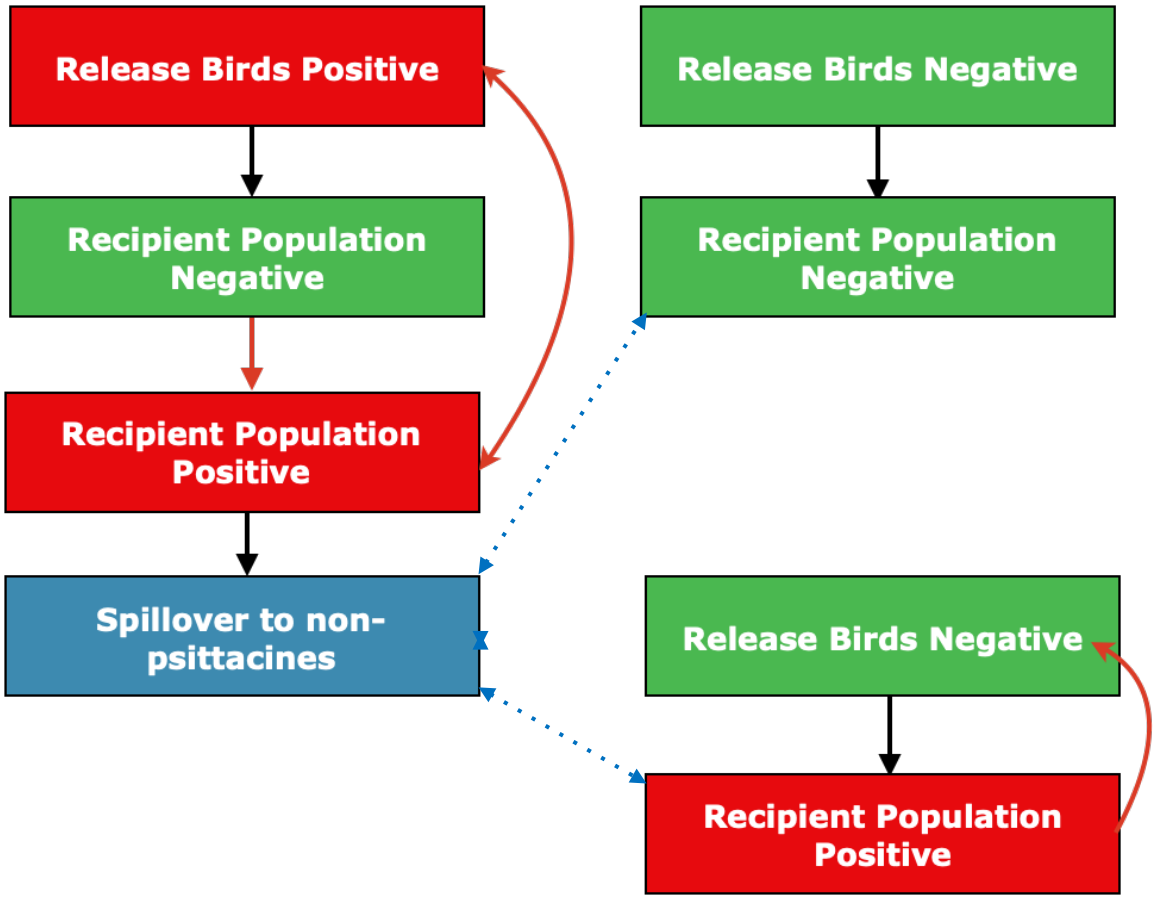
- Donor parrots entering the planning phase
- Recipient parrots in the resident population
- Local avifauna that might also be susceptible or already positive for PBFD

Consequences need to be well defined and well understood or inferred. The decision tree below for Figure 13, Consequences of PBFD on Releases may offer suggestions.

SHOULD the birds be released? Figure 14 **To Release or Not to Release?** offers some suggestions for making a decision.

Figure 13.

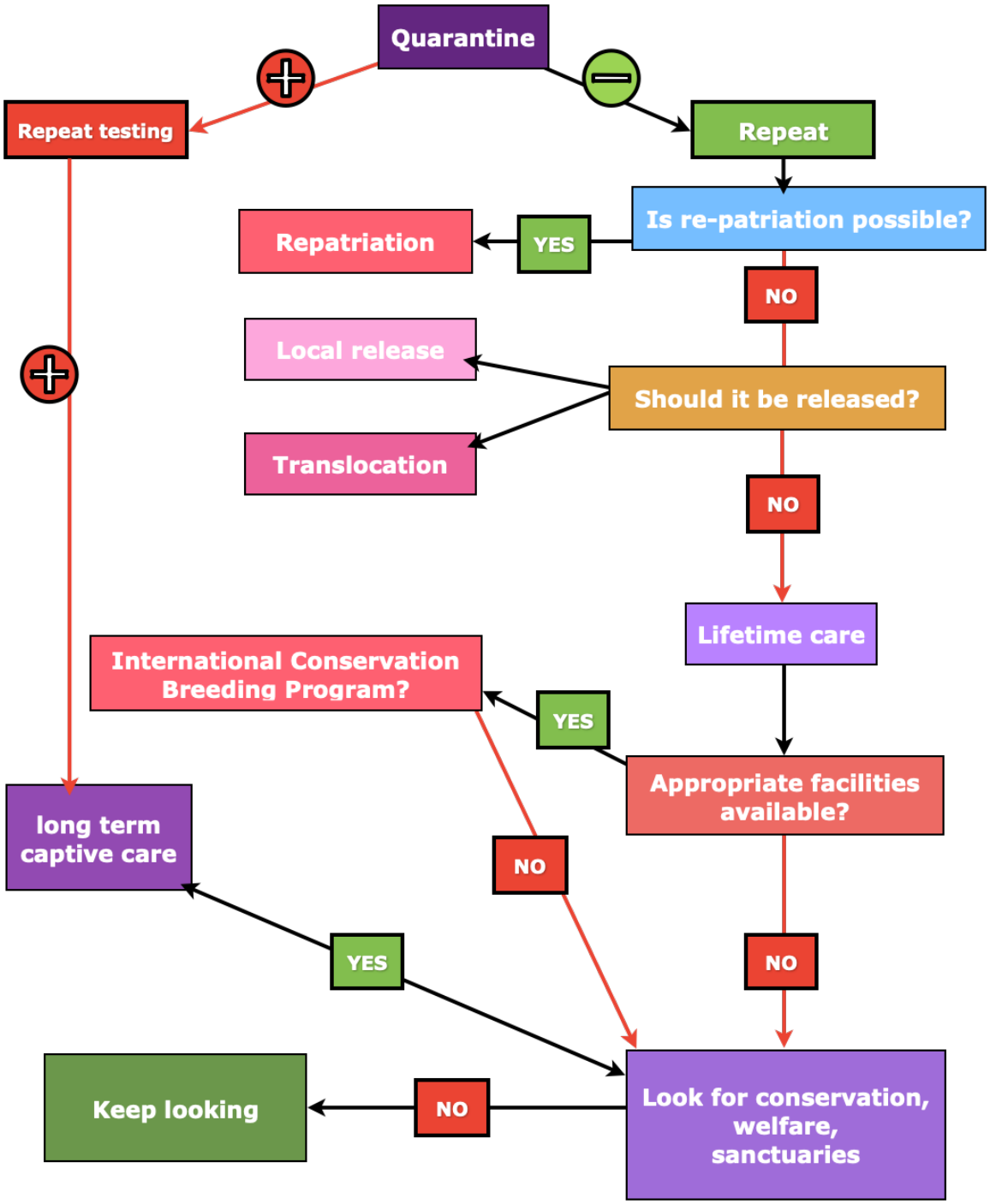
Consequences from PFBD on release/relocation/reintroduction



Red arrows: infection possible; blue dotted lines: bidirectional infections possible

Figure 14.

Flowchart: To Release or not to Release?



Care guidelines

Good husbandry:

- Good nutrition
- Fresh air and sunshine
- Decrease stress
- No overcrowding
- Vegetated, huge aviaries
- Enrichment
- Human contact minimal unless birds choose it
- Minimize secondary infections
- Repeated testing for diverse pathogens
- Cleanliness and intense hygiene
- Immediate veterinary care for any suspect ill birds
- Conduct welfare assessment and improve where needed.

Medical management

A consulting or staff veterinarian with avian and wildlife expertise is essential. Control of co-infections and co-morbidities will require expert guidance to ensure immune recovery.

Immune support

Following the highest standards of husbandry is the first step in immune support, particularly good nutrition and proper ventilation. There are few options for direct immune system treatments in birds, and fewer still delivery systems that could be applied to large numbers in care. At present the only easily available treatment is Beta-glucon, a mushroom-based human food additive that has shown promise in large-scale trials (Chuaychu et al. 2024). It is easy to add the powder to fresh fruits and vegetables and is palatable, is relatively inexpensive

and widely available. Its efficacy and impact has not been established for psittacines nor have trials and pharmacology studies been initiated. But, at present, it seems to cause no harm.

Co-infections

It is easy to forget that PBFD is primarily an immunosuppressive viral disease complex. Concurrent infections, commensals, common sub-lethal pathogens, environmental and opportunistic organisms can cause mortality and morbidity associated with PBFD. As well as the converse: Infections may allow BFDV entry with fatal results.

Trauma and co-morbidities

Wild birds enter human care via traumatic events, natural or anthropogenic disaster, orphaning, confiscations, or as ex-captives. Those situations are often associated with multiple trauma and co-morbidities related to nutrition, poor husbandry, inappropriate or no veterinary care, toxic exposures, pollution and so on. Medical management of complex cases is the standard, not the exception. Wildlife health professionals and caregivers need to abide by standing orders and protocols but be flexible and responsive to the unexpected. PBFD immunosuppression and symptomatic expression is exacerbated.

Recovery

Parrots which overcome infection will require careful recovery as they regain strength and physical optimization. Even after overcoming the infection, it is a delicate and vulnerable situation. Feather quality and replacement will take time. Generally damaged plumage will molt rapidly once normostasis is accomplished. Care must be given to ensure new, immature feathers growing in simultaneously are not injured by falls or aggressive behavior. Repeated testing for pathogens and PBFD with associated appropriate treatment regimens are foundations of safe and rapid recovery. Nutritional support and protection from stressful influences will speed recovery. Veterinary staff should be on hand to monitor and manage the entire recovery period.

When is "depopulation" necessary and how

Depopulation is rarely necessary. Exceptions include mass suffering, mass mortality and morbidity due to overwhelming circumstances. Local legal and ethical issues should be known as part of pre-planning. Methods should be evaluated and planned in advance with proper equipment or pharmaceuticals readily available for emergency use. Veterinary supervision is mandatory for mass euthanasia. See the links below for recommended guidelines.

Disinfecting a contaminated facility

Complete elimination of the highly resistant BFD circovirus is almost impossible to guarantee. Ideally an isolation facility will house positive birds only but that is the exception. Please refer to the many references available on virus disinfection techniques (e.g., Reed 2000) and guidelines.

Effective Disinfectants

There are a number of disinfectants that are effective against circoviruses; cautions must be observed for appropriate human PPE and presence and exposure hazards to birds:

- Virkon S: This potent peroxygen compound is known to inactivate non-enveloped viruses, including circovirus. Use a 1% solution and ensure a minimum 10-minute contact time.
- F10® (F10SC Veterinary Disinfectant): An approved avian disinfectant proven to eliminate pathogens like circovirus (PBFD). It is available in concentrate form and can be used as a spray or nebulizer.
- Sodium Hypochlorite (Bleach): A 1:10 dilution of household bleach (1.5 cups bleach to 1 gallon of water) is effective. It is corrosive and has irritating fumes, so all surfaces must be thoroughly rinsed after the 15+ minute contact time.
- Glutaraldehyde: This disinfectant is specifically suitable for inactivating environmentally resistant viruses.

- Accelerated Hydrogen Peroxide (AHP): AHP products (such as Rescue or Oxivir) are effective against non-enveloped viruses and can work on porous surfaces. They are less corrosive than bleach, but surfaces should still be rinsed.
- Sodium Hydroxide: This is an effective inactivating agent for both enveloped and non-enveloped viruses.

Disinfectants that are less effective or not recommended

- Quaternary Ammonium Compounds: Some research indicates these are not as effective against circoviruses, despite some label claims.
- Chlorhexidine, Ethanol, and Iodine: These disinfectants have shown less effectiveness against hardy circoviruses.
- Phenols (e.g., Lysol): Some products containing phenols are less effective against non-enveloped viruses and are toxic

Cleaning procedure

- Regardless of the product you choose, following a proper cleaning protocol is crucial for achieving effective disinfection:
- Pre-clean: Remove all birds, bedding, food, and water bowls from the area. Clear all visible debris, dirt, and organic matter from surfaces.
- Wash and rinse: Thoroughly wash the surfaces with a soap or detergent, then rinse with water.
- Apply disinfectant: Apply the chosen disinfectant solution, ensuring the surface stays wet for the minimum recommended contact time (usually at least 10–15 minutes).
- Rinse and dry: Thoroughly rinse the surfaces to remove any chemical residue. Allow all surfaces to completely dry before returning birds, food, or water.

If the facility absolutely must be used for birds of unknown PBFD status, it must be stripped down, all furnishings, cages, appliances, etc. broken down and scrubbed thoroughly with soap and water and elbow grease (making certain the cleaners and waste do not become fomites). All surfaces, nooks and crannies, ceiling walls, floors, vents, outlets, drains, windows and so forth need to be cleaned as for a surgical clean room. Any area or surface capable of collecting feather dust is dangerous. Ventilation ducting, fans, and filters need to be cleaned or replaced. Utensils, food and water bowls should be discarded and replaced with new, or autoclaved and used for non-avian taxa. Dedicated laundry appliances should be replaced if unexposed birds might inhabit the facility. They should be cleaned, disinfected and all filters and ducting replaced even if the facility is dedicated to PBFD birds.

Hydrogen peroxide-based disinfectants can be effective but MUST be used properly and instructions for PBFD followed carefully.

Local agricultural departments or offices may have resources to assist and good guidelines for premise disinfection techniques.

Tissues, Samples and Data Collection

If appropriate testing is not available in country, CITES permits are required to ship samples across international borders. As of 2025, only feces-on-paper needs no CITES permit, but some countries require animal health agencies or agriculture permits.

Samples should be collected carefully with purpose-made supplies. Viral collections swabs for PCR should have sterile packaging but no transport media.

sample	supplies	virus	shed	antibody
blood	tubes	PCR	qPCR,HA	HI iELISA
	FTA paper	PCR	qPCR	
	Ethanol 10:1 whole blood	PCR	qPCR	
swab	swab	PCR	qPCR	
	paper	PCR	qPCR	
feather	whole	PCR	qPCR	
	down	PCR	qPCR	
tissue	swab	PCR	qPCR	
	FTA paper	PCR	qPCR	
	formalin	PCR possible	histopathology	IFA
feces	swab	PCR	qPCR	
	FTA paper *	PCR	qPCR	

*No CITES permit needed

Special Cases: Eggs

PBFD is not the only pathogen found in smuggling. Eggs may be exposed to typical psittacine pathogens and many other vertebrate, invertebrate and plant pathogens. Parrot egg pathogen testing primarily targets vertically transmissible diseases that can cause embryo death, poor hatchability, or sick hatchlings; and they are a fomite/contamination risk to the facility and equipment. Advanced testing such as microbiome/pathogen studies can identify unknown, unsuspected or novel pathogens.

Confiscated eggs need to be handled with extreme caution and be evaluated by an avian veterinarian, as artificial incubation and enhanced hygiene are the only management options.

Basic Protocol

It is unlikely for most situations that complete pathogen analysis is possible; at minimum collect swabs for PBFD. Since it immunosuppressive, every effort should be made to collect various samples for PFBD testing and other pathogens, even if the only option is safe storage until analysis is possible. ***Diverse samples should be collected immediately upon seizure as a matter of correct forensic protocol***—genomes of the birds themselves and the pathogens may be useful for legal reasons as well as medical management.

During the Confiscation activity

- Wear Protective Gear: Use gloves, a mask, PPE (Tyvek-type suit), foot covers or rubber boots that can be thoroughly disinfected and dedicated clothing and footwear when handling contaminated eggs or working in an affected area to prevent cross-contamination.
- All tools and equipment may become contaminated. Use disposable or easily disinfected equipment.
- Remove PPE and gear before transport. Do not travel in contaminated PPE; don new PPE at the isolation holding facility.

Sample immediately at seizure:

- Travel substrate from the seized containers
- Egg surface
    - Swab exterior for multiple PCRs
    - Swab for aerobic and anaerobic bacterial cultures and antibiotic sensitivities
    - Samples for virome and microbiome,
    - parasitic PCR/tests (including reptile, human, primate)
    - collect samples for genetic analyses (species, virome, etc)
- Non-viable eggs/embryos pathogen analysis as above
- Blood samples from embryos (if approved or required)
- Eggshell/membrane samples
- Post-mortem on all non-viable or peri-hatching deaths ASAP due to rapid decay

Clean the eggs if necessary

The cleaning of confiscated eggs serves as a precautionary measure to minimize the risk of equipment and facility contamination. In such procedures, the preservation of embryo viability may not be the foremost consideration. Conventional methods for removing contaminants from eggs may prove unsuitable under these circumstances. When faced with choices such as euthanasia or the inherent risks associated with cleaning—particularly in the case of endangered species—disinfection often becomes the primary focus. For eggs exposed to PBFD, stringent biosecurity protocols are imperative, given the virus's notable resilience in environmental conditions and its resistance to many standard disinfectants. The overriding objective is to prevent horizontal transmission, which could occur via contaminated eggshell surfaces, incubators, or hatchlings.

The primary goal is to prevent horizontal transmission (from the contaminated eggshell surface to other eggs, the incubator, or hatchlings).

- Do not use abrasive materials to clean eggs, as this can damage or remove the protective cuticle. Use a soft sterile cloth or paper towel (these are almost sterile) to wipe down the exterior avoid abrasive cleaning
- If exposure is certain: PBFD is hard to kill, the eggshell should be cleaned using a safe and proven effective disinfectant, such as a peroxide-based cleaner, using the correct contact time. Apply a proven effective disinfectant.
    - The PBFD virus is resistant to many common disinfectants but is susceptible to peroxide compounds and specific peroxygen compounds like Virkon S or acidified bleach solutions.
    - Contact Time is Crucial: The disinfectant must remain in contact with the shell for the least amount of time to be effective yet not compromise egg integrity.
- Do not use water unless performing a full wash procedure with a warmer solution to avoid pulling contaminants into the egg. the water/solution temperature must be significantly warmer than the egg itself (e.g., 110º to 120ºF). Using cold water creates a vacuum, pulling bacteria and the cleaning solution through the shell pores into the egg.
- Dry Thoroughly: Ensure eggs are thoroughly dry before placing them into the incubator.

Timeline

SAMPLE IMMEDIATELY AT SEIZURE:

- Travel substrate from the seized containers
- Egg surface
- Non-viable eggs/embryos pathogen analysis as above

- Blood samples from embryos if approved
- Eggshell/membrane samples
- Post-mortem on all non-viable or peri-hatching deaths

ARRIVAL AT HOLDING FACILITY:

- Wipe down or lean eggs if needed
- Re-sample exterior for PBFD
- Place in sterilized egg incubator
- List pathogens of interest and collect appropriate samples for testing going forward (always included PBFD even if prior tests were negative)

1ST WEEK, THEN WEEKLY UNTIL HATCHING

- Imaging of egg and embryo Candling, radiography, etc.)
- re-test exterior at 7 d
- Blood/fluids/yolk sampling 1st week: antigen and antibody tests where appropriate
- Re-test incubator surfaces for PBFD

HATCHING

- Visually examine chicks carefully
- Sample fluids, membranes and eggshells for pathogens
- Blood sample (best) or blood feather for PBFD
- asap 1st week (list of suspected pathogens from prior testing results)

CHICK TESTING PROTOCOL

- feather dander can be used for HA and HI

- An initial positive test requires retesting in 60-90 days to distinguish between a transient infection and a persistent carrier state.
- As per species and pathogens previously detected

Weekly Environmental and/or brooder PBFD

Care of eggs: Incubation

- Incubate eggs in a completely separate, dedicated incubator that is in isolation from all other birds and equipment.
- Quarantine: Any resulting hatchlings should be raised in a strict quarantine area, with stringent biosecurity measures (including personnel restricted to the care of these eggs and no other avian species) in place to prevent the spread of the virus to other birds or areas.
- Veterinary Consultation: Work closely with an avian veterinarian to develop a testing and management plan for the hatchlings and the adult birds.

Testing Confiscated Eggs for PBFD

The most practical and feasible testing on confiscated eggs is a surface sample from the egg for PCR. More invasive and expensive testing is unlikely in the world of confiscations and wildlife trade and wildlife rehabilitation. It is then fortunate that dry swabs intended for collection of viral samples can be stored for some time and are relatively inexpensive. Egg surface PCRs should be used as a screening tool, and chicks need to be tested via multiple modalities at a later date to validate results.

Testing Caveats

- No Standard Live Egg Test: There is no standard, non-invasive method for testing a developing embryo for PBFD without potentially

harming it. Obtaining a sample from a live, developing embryo without causing harm is extremely difficult and risky.

- Post-Mortem Analysis: If an embryo dies during incubation or a hatchling dies shortly after hatching, a veterinarian can take post-mortem samples (e.g., swabs of the liver, spleen, kidney, or feather follicles) for PCR testing to confirm if PBFD was the cause.
- Blood or Feather PCR Test: A veterinarian will collect a blood sample or suspicious-looking feather samples for a PBFD DNA test (PCR assay). This is the standard method for diagnosing infection in live birds.
- Environmental Swabs: incubator surfaces, air filters, and equipment tested via PCR to detect the virus in the environment, confirming exposure risk even if the birds themselves currently test negative.
- Follow-Up: A single positive test should be taken seriously but requires retesting (usually after 45-90 days) to distinguish between a transient infection the bird can clear and a persistent carrier state.
- Environmental Swabbing: The PBFD virus is extremely resilient and can survive in feather dust and feces for months. Swabs from nesting boxes, incubators, air filters, and surfaces can be tested by PCR to confirm the presence of the virus in the environment.
- Post-Mortem Testing: If an embryo dies in the shell or a hatchling dies shortly after hatching, post-mortem swabs or tissue samples (liver, spleen, kidney) can be collected by an avian veterinarian for PCR testing to determine if PBFD was the cause of death.
- Vertical Transmission: The threat to a negative egg from environmental exposure is unknown. Egg hygiene is warranted. Vertical transmission from parent birds is well documented, meaning enhanced hygiene of the shell alone may not prevent the disease.

Other Pathogens

Birds confiscated from wildlife trade often suffer multiple, concurrent serious infections. Expected pathogens reported from confiscated parrots and should be tested on the eggs include:

Viruses:

- Psittacine Beak and Feather Disease (PBFD) circovirus: A highly contagious and often fatal circovirus that can be vertically transmitted and remain viable in the environment for months.
- Avian Polyomavirus (APV): A significant cause of disease and mortality in young birds, also vertically transmissible.
- Avian Encephalomyelitis Virus: Can cause temporary drops in egg production in adults and neurological signs in young birds, with vertical transmission being the main route.
- Herpesviruses (including Pacheco's Disease virus): Some strains are thought to be egg-transmitted and can cause early embryonic death.
- Avian Influenza Virus and Newcastle Disease Virus: Although vertical transmission is considered less likely for some strains (due to infected hens stopping egg-laying), eggs can be contaminated by feces and act as a source of infection.

Bacteria and other organisms:

- *Chlamydophila psittaci* (Psittacosis): A primitive bacterium that can be transmitted through the egg to the embryo, potentially causing the embryo to die or hatch as a carrier.
- *Salmonella* spp.: Can penetrate the eggshell or be transmitted vertically, leading to embryonic death or weak hatchlings with systemic infections.
- *Escherichia coli*: A common cause of yolk sac infections and omphalitis (navel infection) in hatchlings, which often leads to death. It typically enters from fecal contamination of the shell.
- *Mycoplasma spp*.: These bacteria (may originate from domestic poultry simultaneously smuggled or that were co-housed in smuggling operations with wildlife) lack a cell wall and can be transmitted through the egg, causing respiratory issues and sometimes abnormal eggshell formation.

- *Staphylococcus* spp.; and *Proteus* spp. And multiple mammalian and herptile enteric pathogens
- Fungi: *Aspergillus* and *Candida* spp. As well as opportunistic fungal pathogens can contaminate the environment and eggs, causing respiratory infections in hatchlings.
- GI parasites can contaminate outer surfaces and possibly penetrate the eggshell.

Pathogen	Type	Potential Effects on Eggs/Embryos/Hatchlings
Psittacine Beak and Feather Disease (PBFD) virus	Viral	Vertically transmitted; can cause fatal infections, especially in young birds; infected embryos/hatchlings consistently develop the disease.
Avian Polyomavirus (APV)	Viral	Can cause high mortality in young birds; virus DNA can be detected in blood/swabs; vertical transmission is a concern in breeding facilities.
Chlamydia psittaci	Bacterial	Can be vertically transmitted from an infected hen to the embryo, potentially causing embryo death or weak, infected hatchlings.
Salmonella spp.	Bacterial	Can cause embryos to die in the shell or result in weak hatchlings that die shortly after hatching; can penetrate the eggshell and be vertically transmitted.
Mycoplasma spp.	Bacterial	Causes respiratory disease and can become systemic, leading to oviduct infections and potential transovarian transmission to eggs, affecting hatchability.
E. coli	Bacterial	Can enter the egg from an infected reproductive tract or through fecal contamination of the shell; often causes yolk sac infections (omphalitis) and late-incubation/early-hatch mortality.
Aspergillus spp.	Fungal	Environmental contaminant that can enter eggs through the shell pores, potentially causing respiratory distress and mortality in embryos or hatchlings.

Useful egg references:

Diseases Transmitted to Eggs
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Links

Wild Parrot Specialist Group Webpage

IUCN SSC Wild Parrot Specialist Group

Australia

Beak and feather disease virus in Australian birds

Brazil

ICMBio toma medidas emergenciais para conter circovírus em ararinhas-azuis reintroduzidas na natureza

Blogs

Globalization of Diseases with the Wildlife Trade: Psittacine Beak and Feather Disease found in Great Green Macaws (Ara ambiguus) in Costa Rica - Association of Avian Veterinarians

Guidelines and Information

EAZA Parrot TAG Virus management for Parrots

International Wildlife Rehabilitation Council

Conservation Planning Specialist Group

IUCN SSC Conservation Translocation Specialist Group

IUCN SSC Wildlife Health and Disease Specialist Group

Parrot Researchers Group

Wildlife Confiscations Network

Wildlife Disease Association

Euthanasia Guidelines

American Veterinary Medical Association

Australian Veterinary Association

CITES laboratory samples permitting

CITES RAPID MOVEMENT OF WILDLIFE DIAGNOSTIC SAMPLES AND MUSICAL INSTRUMENTS

Diagnostics

MiniPCR

BentoLab

MiDog (microbiome/pathogen)

FTA Cards

Buy FTA cards

Testing in Australia

Projects

Cape Parrot Project

Mauritius Parrot Project

Ebony Forest

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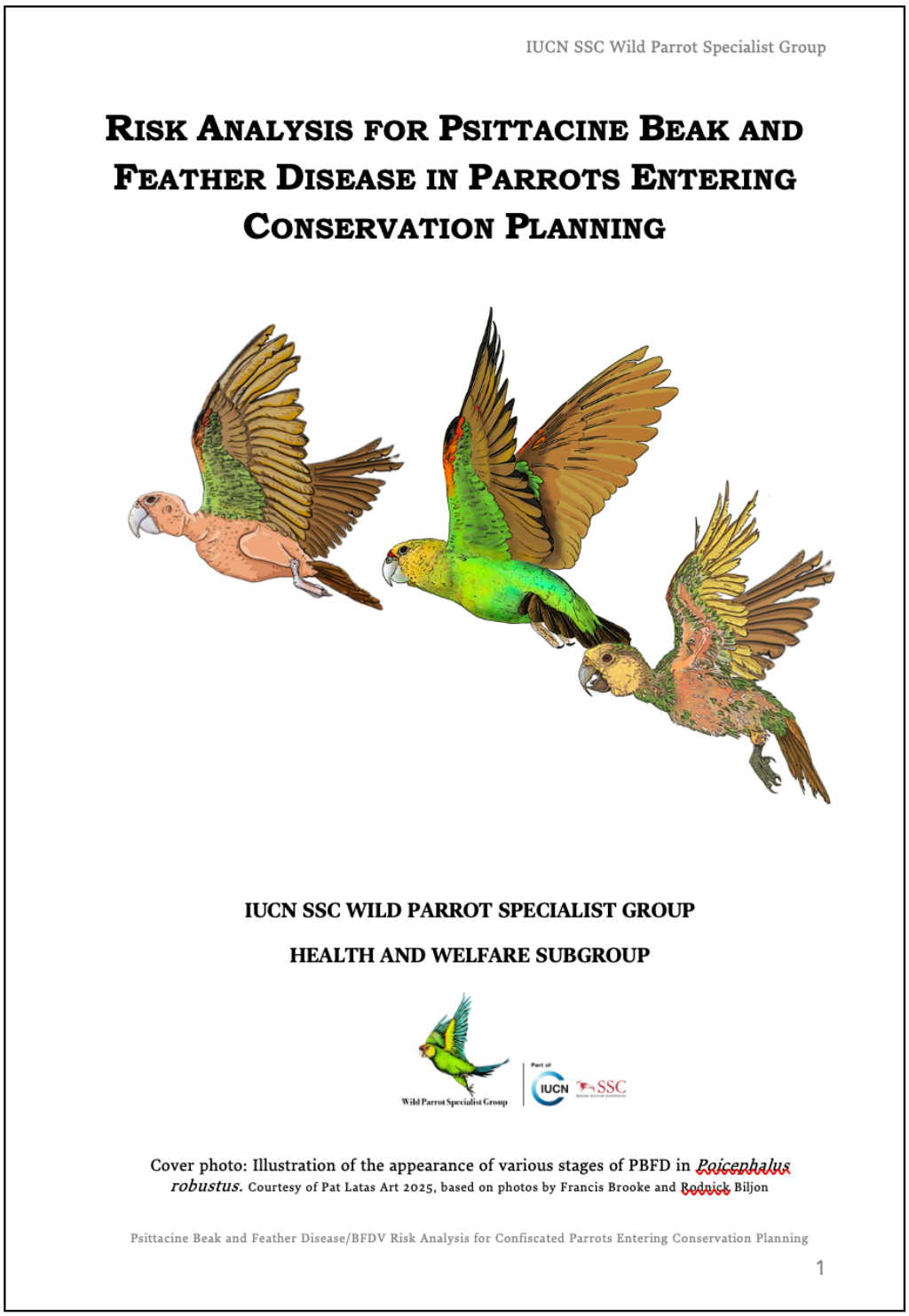
Risk Analyses

[Wildlife Disease Risk Analysis for PBFD in Parrots for Conservation Planning]



IUCN SSC Wild Parrot Specialist Group

RISK ANALYSIS FOR PSITTACINE BEAK AND FEATHER DISEASE IN PARROTS ENTERING CONSERVATION PLANNING

IUCN SSC WILD PARROT SPECIALIST GROUP

HEALTH AND WELFARE SUBGROUP

Cover photo: Illustration of the appearance of various stages of PBFD in *Poicephalus robustus*. Courtesy of Pat Latas Art 2025, based on photos by Francis Brooke and Rodnick Biljon

Psittacine Beak and Feather Disease/BFDV Risk Analysis for Confiscated Parrots Entering Conservation Planning

1

Conservation Planning/A-P-A

TBA

Trade and PBFD

TBA
Legal/illegal confiscations
Eggs
Chicks
Juveniles
Adults
Body parts