Flying-fox Paralysis Syndrome: Case definition, triage & treatment protocol for veterinarians and wildlife care providers

Version 2.2
Developed by the Paralysis Syndromes Working Group
Last updated: September 2026

Contents

1. Case presentation & clinical description 2
2. Data collection 3
3. Categorisation of clinical severity 4
4. Assessment & Treatment 5
5. Prognosis and decision making for euthanasia 6
6. Release 6
7. Sample collection and pathological investigations in dead bats 6

Appendix A – Reference ranges 7
Appendix B – Body Condition Scoring 8
Appendix C – Photos 9

Since December 2020, unusual clusters of flaccid paralysis have been identified in flying-foxes in South East Queensland and North East NSW, particularly over the summer months, though sporadic cases can occur at any time of year. To date, black flying-foxes (BFF, *Pteropus alecto*), grey-headed flying-foxes (GHFF, *P. poliocephalus*) and little red flying-foxes (LRFF, *P. scapulatus*) have been affected. Cases with a similar clinical presentation have also been reported in other coastal areas of Queensland.

In lieu of a diagnosis the syndrome has been named Flying-fox Paralysis Syndrome (FFPS). Investigations into the cause of FFPS are ongoing. This Triage and Treatment Protocol is intended to provide guidance to veterinary personnel and rehabilitators on the best practice management of FFPS cases.

PUBLIC HEALTH WARNING

Members of the public who find an injured or sick bat should not touch the animal and instead contact a wildlife rehabilitation organisation or local veterinarian.

Only people who are trained, wearing appropriate personal protective equipment (PPE) and appropriately vaccinated with ongoing immunity should handle bats. Information on PPE for handling bats is available at the WHA Bat Health resources page.

Clinical signs of FFPS overlap with those of ABLV and it may be difficult to distinguish them clinically. ABLV infected bats with clinical disease usually die within 10 days of onset of signs.

1. Case presentation & clinical description

FFPS should be suspected in bats that present with progressive flaccid paralysis, where known causes of paralysis have been excluded.

Cases can be difficult to distinguish clinically from Australian bat lyssavirus (ABLV), and ABLV should always be considered as a possible cause of any neurological symptoms in bats.

The differential diagnoses listed below should be considered and excluded where possible. If you suspect a notifiable disease, call the EAD Hotline on 1800 675 888.

	Higher priority to investigate and/or exclude	Lower priority to investigate and/or exclude
Infectious	• Australian bat lyssavirus (ABLV) or other novel lyssavirus	• Toxoplasmosis • Other viral, bacterial, parasitic or protozoal infection
Toxicological	• Plant toxin, and plants high in soluble oxalates • Botulism • Tick Paralysis • Algal toxins • Organophosphates and other pesticides/herbicides, including neonicotinoids	• Fungal neurotoxin • Insect neurotoxin • Heavy metals, including lead
Parasitic	• Angiostrongyliasis	
Trauma	• Spinal damage • Concussion • Electrocution	
Metabolic	• Hypocalcaemia secondary to soluble oxalate poisoning or other plant poisoning	• Liver disease • Kidney disease
Immune Mediated		• Acquired myasthenia gravis or unknown aetiology

Clinical signs and case progression

Clinical manifestations of paralysis include impaired mobility, impaired swallowing and tongue control, impaired blinking and impaired respiration across four identified stages of severity, detailed in Table 1 (Category 1 – 4). More severely affected individuals are expected to demonstrate all four manifestations. Body condition is variable, ranging from poor condition to very good condition.

Progression over the four identified stages of severity may occur acutely over a period of hours or more chronically over days to weeks.

The syndrome mostly affects adult and sub-adult flying-foxes, rather than dependent pups that are not yet foraging independently. Cases are reported more often in males than in females, regardless of time of year. Any apparent association with individuals experiencing high energy demand (e.g. reproduction) appears to reflect the time of year when the syndrome most commonly occurs.

No definitive laboratory criteria have currently been identified. Clinical pathology associated with sequalae such as dehydration and shock may be expected (see Appendix A for reference ranges for haematology and plasma biochemistry).

Case definition

The descriptions below identify features that must be met for an individual flying-fox to be considered a suspect, probable or confirmed case of FFPS. These definitions aim to assist with triage, treatment, prioritising individuals for further diagnostic testing and subsequent epidemiological investigations.

Suspect case:

- Consistent with the clinical description (presenting live or dead) (see Table 1). Note that flying-foxes that are dead on presentation to a veterinarian, bat rehabilitator or similarly qualified person can meet the clinical description based on a history of signs prior to death as reported by a member of the public
  OR
- Dead on presentation with no clinical history AND occurrence is spatio-temporally consistent with other probable, clinically consistent or confirmed cases (particularly between December – March, anecdotally during periods of high rainfall) AND no other obvious causes (e.g. trauma, electrocution, ticks).
    - Evidence of consistent clinical signs on the carcass (e.g. nasal discharge or other signs in Table 1) may increase the level of suspicion.

Probable case:

- Consistent with the clinical description (presenting live or dead) (see Table 1)

AND

- Other differential diagnoses have been ruled out via diagnostic testing (as a minimum, ABLV testing and a full histopathological workup which encompasses CNS (brain and spine), and preferably peripheral nerve and skeletal muscle)

AND

- May or may not be spatio-temporally consistent with other probable cases.

Confirmed case:

Definition not yet possible until a cause is identified.

2. Data collection

A minimum metadata set should be collected for bats presenting with suspected or probable FFPS:

- Species
- Location found
- Sex
- Age
- Forearm length
- Weight
- Body condition score (see Appendix B)
- Case context (e.g. is this case part of a broader mortality event, if so, event details (numbers affected etc) or other relevant case information (environmental / weather conditions, local food sources being utilised etc)

3. Categorisation of clinical severity

Table 1: Categorisation of clinical severity [1] [2]

Category	Impaired mobility	Impaired swallowing[3]	Impaired blinking	Impaired respiration	Other	Prognosis
1	Mild generalised weakness, unable to hold wings against body. Impaired flight with no lift, can climb.	Able to swallow. May have uncoordinated tongue movement.	Weepy eyes.	Normal respiratory rate and effort.	Dehydration[4].	Can recover well with supportive care. See Section 4. Treatment and Section 5. Prognosis and decision making for euthanasia.
2	Moderate generalised weakness. May use thumbs to support hanging. Unable to hold wings against body. No flight.	Impaired swallow reflex. Likely to have uncoordinated tongue movement, with tongue often protruding.	Reduced ability to close eyelids, dry eyes, may have corneal ulcers forming[5].	Some respiratory difficulty. May be open–mouth breathing, without teeth showing.	Dehydration, wings may take on a crepe-like appearance.	Requires more aggressive treatment to survive. Nil by mouth. See Section 4. Treatment and Section 5. Prognosis and decision making for euthanasia.
3	Severe, generalised weakness. May be hanging or found on ground. Unable to hold wings against body. May be able to move legs. No flight.	Unable to swallow, no gag reflex. Uncoordinated tongue movement, with tongue protruding.	Unable to close eyelids. Sunken eyes, may have severe corneal ulcers.	Obvious, severe respiratory distress. Open mouth breathing, with gaping and teeth showing.	Severe dehydration, wings may take on a crepe-like appearance. May have abrasions due to struggling on the ground.	Euthanasia recommended. See Section 5. Prognosis and decision making for euthanasia.
4	Unable to move. May be hanging or found on ground. Unable to hold wings against body. Unable to regrip. No flight.	Unable to swallow, no gag reflex. Uncoordinated tongue movement, with tongue protruding. May have clear, bubbly nasal discharge.	Unable to close eyelids. Sunken eyes, may have severe corneal ulcers or corneal swelling.	Ineffective breathing (shallow, abdominal) with high respiration rate. Cyanotic (pale, blue-grey gums). Can have serous nasal discharge and crackles on pulmonary auscultation.	End stage individuals are moribund, show extreme weakness, extensive paralysis, severe dehydration, hypoglycaemia, hypothermia and respiratory signs likely all sequelae of paralysis and secondary effects, including shock or neurological signs such as seizures, shivering or anisocoria. May be in poor body condition[6]. May have abrasions due to struggling on the ground.	Euthanasia recommended. See Section 5. Prognosis and decision making for euthanasia.

[1] Clinical presentations may not always fit completely in one category.
[2] See Appendix C for supporting photos
[3] Swallowing is a more consistent indicator of category than tongue control
[4] LRFF less likely to show dehydration than GHFF/BFF
[5] LRFF less likely to have corneal ulcers than GHFF/BFF
[6] Body condition is variable across all species, however LRFF less likely to show loss of body condition than BFF/GHFF

4. Assessment & Treatment

Triage and first aid (prior to veterinary assessment)

- Initial examination should include a careful inspection for signs of trauma (including signs of electrocution), paralysis ticks or tick attachment sites, that may indicate a different cause for the paralysis.
- Cases should be categorised based on the severity of clinical signs (See Section 3. Categorisation of clinical severity). Categorisation should be reviewed regularly to ensure ongoing delivery of the most appropriate treatment, or to determine if euthanasia is indicated. Note that clinical presentations may not always fit completely in one category.
- Nothing should be provided orally unless controlled swallowing is confirmed. Assess ability to swallow once hydrated and alert. Tilt bat down and observe ability to lap and swallow fluid from a syringe. This ensures fluid drains from the mouth if they are unable to swallow to reduce aspiration risk.
- First aid should be provided as indicated, including:
    - addressing extremes of temperature (most animals in shock will be hypothermic, however bats which are unable to thermoregulate due to paralysis may be hyperthermic)
    - oxygen therapy if available and required.
    - application of glucose gel or paste on gums (if safe to do so)
    - administration of fluids (initially 10% of body weight as warmed sub cutaneous fluids 50/50 Hartmann's and 2.5% glucose; can repeat with 5% BW after 12 hours or as required)
    - application lubricant eye gel or drops in eyes (thickest available is preferred)
- Paralysis syndrome is not considered contagious but basic biosecurity between cases should always be followed.
- Follow up veterinary assessment and management.

Veterinary management

- Initial examination should include a careful inspection for signs of trauma (including signs of electrocution), paralysis ticks or tick attachment sites, that may indicate a different cause for the paralysis.
- Reassessment of initial categorisation of clinical signs and prognosis (see Section 3. Categorisation of clinical severity). Categorisation should be reviewed regularly to ensure ongoing delivery of the most appropriate treatment, or to determine if euthanasia is indicated, especially where bats are non-responsive to treatment or continue to deteriorate (see 6. Prognosis and decision making for euthanasia)
- Veterinary management should be provided as indicated, including:
    - pain relief, avoiding NSAIDs until hydration improves (topical ophthalmic NSAIDs are an exception)
    - oxygen therapy if available and required
    - glucose correction as required
    - administration of fluids (sub cut for Category 1 if required, IV therapy recommended for Category 2), including addressing electrolyte abnormalities (see Appendix A)
    - ophthalmic treatment
- If required, general anaesthesia should be supplied via mask +/- nasal O2 where possible
- Nebulisation may assist antibiotic treatment for aspiration pneumonia
- Refer to a wildlife hospital or wildlife vet if more specialised or experienced management is required.
- Refer to a wildlife rehabilitation organisation or experienced wildlife rehabilitator once stable and able to be managed in a rehabilitation setting (e.g. when swallowing, breathing and

hydration are normal, and concurrent issues including ulcers can be suitably managed by the receiving rehabilitator).

Ongoing care for rehabilitation

- Bats can take months to fully recover and require ongoing intensive care to manage clinical signs, for example:
    - nothing should be provided orally unless controlled swallowing is confirmed; sub-cutaneous fluids will be required until they are swallowing strongly and self-feeding, which may be for several weeks.
    - eye lubrication
    - some bats cannot hang full time for upwards of 2-3 weeks so alternative management is required
    - monitoring during the recovery period is important as clinical signs can relapse and impact patient welfare
    - comorbidities or high physiological load (e.g. pregnancy or lactation) may complicate and/or extend recovery.
- See 5. Prognosis and decision making for euthanasia and contact your rehabilitation organisation for additional resources about flying fox care.

5. Prognosis and decision making for euthanasia

Both the welfare of individual affected bats and the resourcing of an intensive and prolonged period of treatment and rehabilitation should be considered when making decisions about euthanasia. You must also follow any relevant legislation in your jurisdiction.

Euthanasia is recommended for individuals with Category 3 or 4 clinical severity due to a poor prognosis for recovery, however the overall condition and welfare of individual bats should be taken into consideration regardless of the clinical FFPS category.

The rehabilitation of flying-foxes with FFPS is intensive, and requires specialised skills, adequate resourcing and staffing capacity, and specialised facilities. Bats can take months to fully recover; some cannot hang full time for upwards of 2-3 weeks. Where resources for appropriate treatment and rehabilitation are insufficient or unavailable, cases that cannot be redirected to appropriately resourced facilities should be euthanased. Prioritisation based on severity of clinical signs (see Section 3. Categorisation of clinical severity) may be useful when resources are limited to direct treatment to cases most likely to recover.

6. Release

Bats can be released once they meet standard release criteria. You must follow any relevant legislation in your jurisdiction. Contact your rehabilitation organisation for additional information.

7. Sample collection and pathological investigations in dead bats

Clinical signs of FFPS overlap with those of ABLV and it may be difficult to distinguish them clinically. ABLV infected bats with clinical disease usually die within 10 days of onset of signs[7]. ABLV testing of dead bats is conducted at jurisdictional government laboratories.

If you are interested in submitting samples for diagnostic investigation, contact your State/Territory WHA Coordinator to discuss whether further diagnostic screening is appropriate at https://wildlifehealthaustralia.com.au/Incidents/WHA-Coordinator-Contacts#

[7] AUSVETPLAN Lyssaviruses

Appendix A – Reference ranges

This table, below, details haematological and plasma biochemistry reference ranges for clinically normal wild-caught adult *P. Alecto* from McMichael et al (2015). Please see full paper (open access) for complete details: [McMichael L, Edson D, McLaughlin A, Mayer D, Kopp S, Meers J, et al. (2015) Haematology and Plasma Biochemistry of Wild Black Flying-Foxes, (*Pteropus alecto*) in Queensland, Australia. PLoS ONE 10(5): e0125741. https://doi.org/10.1371/journal.pone.0125741]

Parameter	n	Mean	95% CI	Range	Ref Range (n)
Hb (g/L)	293	163.49	140.37–186.60	136.00–218.00	143.40–182.18 (280)
RCC ($x10^{12}$/L)	293	9.13	7.85–10.41	7.60–12.60	8.01–10.19 (282)
Hct	293	0.47	0.41–0.53	0.39–0.62	0.42–0.52 (286)
MCV (fL)	293	51.79	47.02–56.56	45.00–58.00	47.34–56.12 (284)
MCH (pg)	293	17.97	16.44–19.50	16.00–21.00	16.53–19.31 (286)
MCHC (g/L)	293	347.03	329.38–364.68	318.00–388.00	331.82–361.30 (282)
Plat ($x10^9$/L)	293	367.39	189.32–545.45	106.00–719.00	217.54–499.14 (276)
WBC ($x10^9$/L)	293	5.96*	2.95–12.03	2.50–22.00	2.38–10.01 (277)
Neut ($x10^9$/L)	293	3.57*	1.64–7.74	0.90–12.50	1.29–6.18 (278)
Lymp ($x10^9$/L)	293	1.72*	0.50–5.90	0.30–12.10	0.58–5.11 (279)
Mono ($x10^9$/L)	293	0.14*	0.03–0.62	0.00–1.20	0.03–0.50 (282)
Eos ($x10^9$/L)	293	0.06*	0.00–2.33	0.00–4.59	0.00–2.17 (291)
Baso ($x10^9$/L)	293	0.00*	0.00–0.01	0.00–0.01	0.00–0.01 (293)
Na (mmol/L)	260	138.39	133.50–143.27	132.00–147.00	134.27–142.00 (256)
K (mmol/L)	260	4.02*	2.68–5.76	2.50–9.80	2.84–4.93 (250)
Cl (mmol/L)	260	104.99	98.23–111.74	92.00–114.00	99.07–111.22 (259)
Bicarb (mmol/L)	260	14.68	10.38–18.97	9.00–21.00	10.72–18.34 (252)
Anion gap (mmol/L)	260	22.75*	17.39–29.22	15.00–38.00	17.70–27.14 (248)
Ca (mmol/L)	258	2.41	2.14–2.68	1.98–2.82	2.11–2.71 (247)
P (mmol/L)	258	1.4	0.62–2.19	0.50–2.50	0.66–2.11 (253)
Glucose (mmol/L)	993	6.8*	4.3–10.7	3.5–21.4	4.5–10.0 (955)
AST (U/L)	258	76.83*	25.21–174.05	23.00–502.00	28.85–135.71 (246)
ALT (U/L)	258	15.84*	6.56–38.28	< 10.00–52.00	9.02–30.06 (235)
ALP (U/L)	259	407.46*	156.90–877.52	69.00–1289.00	102.01–697.82 (247)
Protein (g/L)	257	65.51	54.05–76.98	50.00–82.00	55.27–75.11 (243)
Albumin (g/L)	255	36.12	29.57–42.67	27.00–44.00	30.03–41.73 (244)
Globulin (g/L)	255	29.34	22.32–36.35	20.00–40.00	22.97–35.10 (245)
Alb/Glob Ratio	255	1.25	0.95–1.54	0.80–1.70	0.93–1.54 (241)
Urea (mmol/L)	260	1.36*	0.25–7.57	< 0.50–7.40	0.25–7.57 (260)
CK (U/L)	254	466.28*	40.07–1577.35	57.00–9552.00	52.83–857.82 (237)
Triglyc (mmol/L)	253	0.19*	0.05–0.74	< 0.10–1.20	0.05–0.61 (244)
GGT (U/L)	259	-	-	< 5.00–19.00	-
Creatinine (µmol/L)	260	-	-	< 20.00–181.00	-
Bilrubin (µmol/L)	260	-	-	< 2.00–8.00	-
Chol (mmol/L)	253	-	-	< 0.50–1.40	-

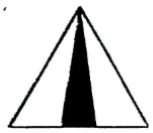
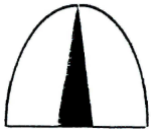
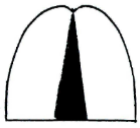
*Natural log transformation.

doi:10.1371/journal.pone.0125741.t001

This table, right, details normal blood values for *Pteropus poliocephalus* and *P. scapulatus* from O'Brien & Endean (2001). Please see full paper (open access) for complete details: O'Brien GM, Endean CK (2001) Normal blood values for *Pteropus poliocephalus* and *P. scapulatus*. Australasian Bat Society Newsletter 16:10

	Grey-headed Flying Fox *P. poliocephalus*	Little Red Flying Fox *P. scapulatus*
Haemoglobin (g/L)	157 - 199	151 - 207
RBC Count (10^{12}/L)	8.2 - 9.4	9.0 - 11.5
PCV (L/L)	0.435 - 0.555	0.461 - 0.556
MCHC (g/L)	344 - 376	303 - 407
MCH (pg)	18 - 22	15 - 20
MCV (fL)	54 - 59	44 - 56
WCC (10^{9}/L)	11 - 22	10 - 16
Neutrophils %	33 - 45	43 - 63
Lymphocytes %	49 - 58	19 - 43
Monocytes %	3 - 10	2 - 13
Eosinophils %	3 - 6	3 - 12
Basophils %	0 - 3	0 - 1
Sodium (mmol/L)	119 - 145	136 - 146
Potassium (mmol/L)	4.8 - 6.8	4.8 - 6.6
Chloride (mmol/L)	103 - 109	105 - 113
AST (U/L)	41 - 73	197 - 373
ALT (U/L)	1 - 28	9 - 47
Alk. Phos. (U/L)	549 - 1564	32 - 2390
CPK (U/L)	105 - 194	122 - 359
Protein (g/L)	73 - 77	74 - 87
Albumin (g/L)	44 - 49	46 - 53
Globulin (g/L)	25 - 33	27 - 36
A/G	1.3 - 2.0	1.3 - 1.8
Urea (mmol/L)	1 - 3	2 - 4
Creatinine (mmol/L)	40 - 56	15 - 61
Glucose (mmol/L)	2 - 6	5 - 8

Appendix B – Body Condition Scoring

Body Condition Score[8]	Muscle	Sternum	Contour	Condition	Diagram[9]
1	No observable palpable muscle on either side of the sternum	Extremely pronounced, individual sternebrae obviously visible	Concave	Critical, Poor. Severely Emaciated.	
2	Minimal palpable muscle on either side of the sternum	Easily palpated, sternum visibly prominent	Flat	Less than fair. Thin.	
3	Moderate palpable muscle on either side of the sternum	Easily palpated	Convex	Fair, minimally healthy. Adequate.	
4	Muscle mass level with sternum apex	Less pronounced with palpation	Semicircle	Healthy, greater than fair. Healthy.	
5	Muscle mass above the sternum apex	Minimally distinguished with palpation	Cleavage without palpation	Greater than fair to obese.	

[8] Note score can differ between conscious and anaesthetised bats due to muscle tension.
[9] Transverse view of sternum and pectoral muscles for body condition scoring.

Images provided by Louella Harley and Bat Conservation & Rescue Queensland. Not to be reproduced without permission.

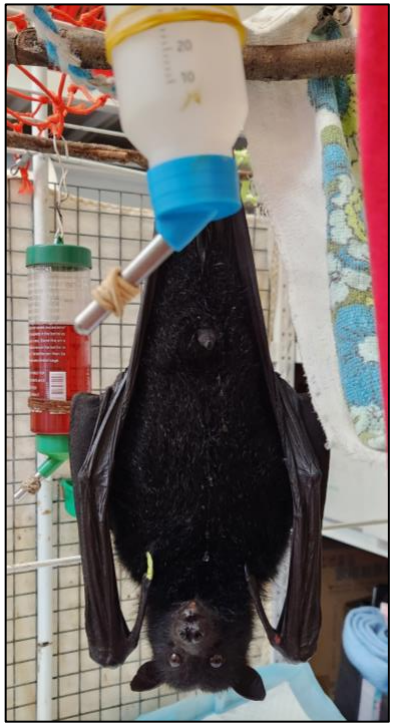
Appendix C – Photos

Weepy eyes, protruding tongue

Weak grip unable to support hanging, unable to hold wings against body, weepy eyes

Loose wing wrap (unable to hold wings against body)

Unable to hold wings against body, abrasions



Unable to hold wings against body, protruding tongue

Unable to hold wings against body