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An overview of bluetongue viruses in Australia

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# Arboviruses in Australia – an overview

- History of bluetongue viruses in Australia;
- Epidemiology;
- Occurrence of disease and pathogenesis;
- Diagnosis and control measures;
- Parallels with Asia.
- Research directions



## Livestock production in Australia

- Prior to 1788 no ruminants in Australia;
- Indigenous animals mostly marsupials (kangaroo, koala);
- Cattle originally imported from UK, sheep from UK and Spain;
- Approximately 25M cattle; 3M dairy cattle
- Currently 100M sheep;
- Small goat population - 1M;
- Pigs, poultry, aquaculture



## Livestock production in Australia

Cattle – raised throughout Australia:

- Beef production in all states;
- Tropical breeds in north based on *Bos indicus*;
- *Bos taurus* mainly in temperate areas;

Sheep production:

- Usually confined to the dryer, “cooler” regions;
- Few sheep in vector zones.





# Livestock production in Australia





# Bluetongue vectors

Distribution and abundance of the vector influenced by:

- Temperature – limited by cold weather/frost
- Rainfall - but not excessive
- Altitude – influence of temperature and gradient
- Wind – can be dispersed by strong winds



## Bluetongue vectors

The biology of the vector determines:

- Distribution – potential limits of virus
- Transmission patterns – not always active annually
- Seasonality of infection (summer/autumn)
- Free areas for quarantine



## Bluetongue virus – some history

- Prior to 1975, bovine ephemeral fever virus caused intermittent major epizootics of disease sweeping from the tropical north to the far south of Australia;
- The virus spread over several thousand kilometres in 1-2 months.
- A vector-borne virus was suspected;







# Bluetongue virus investigations

- During the search for the vector of BEF, mosquitoes and biting midges (*Culicoides* spp) were caught and virus isolation attempted;
- In 1975, an unidentified virus found in the north.
- In 1977, unknown virus shown to be bluetongue.
- No evidence of disease;  
(BTV also recognised in China in 1977 as a cause of disease in sheep)



# Bluetongue virus research

- Systematic studies of the epidemiology of Bluetongue infection of cattle commenced in 1977, using sentinel cattle;
- Search for bluetongue took over from BEF;
- Many viruses isolated and characterised;
- Research undertaken to:
  - Investigate epidemiology of BTVs in Australia;
  - Study pathogenicity of viruses - why no disease in the field?
  - Develop improved diagnostic tests
  - Study duration of viraemia, period of infectivity to insect



## Diagnosis of Bluetongue virus infection.

### Tests available for virus detection:

- Virus isolation, Ag ELISA, PCR (esp qRT-PCR)
- Virus usually required for typing, molecular studies, vaccines
- Inoculation of ece, screen by Ag ELISA followed by passage in cell culture (C6/36 then mammalian cells)
- Identification: Group: Ag ELISA, IPX/IFAT, PCR
- Type specific: Neutralisation, qRT-PCR



## Diagnosis of Bluetongue virus infection.

Tests available for antibody detection:

- Group reactive assays: Sensitive, quick (once sample at lab) and economical;
- eg AGID, bELISA (cELISA) to test serum or plasma, detect any serotype, any animal species;
- Used to map BTV zones/free areas and facilitate virus isolation;
- Type specific serology – VNT/PRNT – research only
- Used to define distribution and movement of individual serotypes, risk of disease, incursions (cross reactivity an issue)



# Biology of bluetongue infection

- Live virus can be detected from 3 to about 50 days (Zhang et al)  
[OIE 60 days]
- Levels of virus very low after 14 - 21 days
- Infective for insects for <28 days
- Vector competence requires 8-10 day incubation period
- Residual RNA (virus components) can be detected by qRT-PCR for many months and can complicate testing



# Biology of bluetongue infection

- Virus and antibodies both detected after about 7 days
- Antibodies persist for several years without re-exposure
- Only indicate past exposure to virus – not an indicator of risk



## Diagnosis of Bluetongue virus infection.

Considerations with tests for antibody detection:

- Tests must have very high sensitivity:
  - Sensitivity:
    - the ability to detect truly infected animals;
    - detect antibodies from very early stages (day 6-7) but last for many years
- (cannot predict when infection occurred);



## Diagnosis of Bluetongue virus infection.

Considerations with tests for antibody detection:

- Tests must have very high specificity;
- Specificity:
  - the ability to correctly classify an uninfected animal (negative result);
  - WITH THE BEST TEST specificity ranges from 98-99.5%;  
(that means 5-20 false positives/reactors per 1,000)
- As sensitivity increases, specificity decreases – a balance  
(AGID less sensitive than bELISA)





## Bluetongue viruses – the international situation

### **Globally:**

- 29 recognised serotypes – several others to be confirmed;
- Serotype determined by antigens that induce neutralising Ab;

### **In Australia:**

- Currently 12 serotypes;
- Serotypes 1, 2, 3, 5, 7, 9, 12, 15, 16, 20, 21, 23.

### **In Asia:**

- At least 14 serotypes;
- Serotypes 1, 2, 3, 4, 5, 9, 11, 12, 15, 16, 17, 20, 21, 23.



## Bluetongue viruses – how many are pathogenic?

### **Globally:**

- Virulence is independent of serotype;
- Can be a spectrum of virulence within a serotype – eg serotype 1;
- Some serotypes may have few if any virulent strains.

### **In Australia:**

- Strains within serotypes 2, 3, 16, 23 can be highly pathogenic.
- NSW BTV1 non-pathogenic; NT BTV1 mildly pathogenic



## Bluetongue viruses – occurrence of disease

- Occurrence and severity (virulence) of disease is influenced by strain of virus;
- Sheep more susceptible than goats and cattle;
- Prior to 2007, disease not observed in cattle – a unique feature of BTV8 (a lab adapted strain)
- Indigenous breeds tend to be less susceptible than introduced breeds.
- Significant disease induced experimentally in Australia with BTV 2, 3, 16, 23. BTV1 in eastern Australia non pathogenic – cf BTV1 (China)



## Control measures for Bluetongue

### **AusVetPlan:**

- No use of vaccine unless a continuing problem
- Live vaccines not an option - have undesirable characteristics – foetal infection, excreted in semen, spread by insects;
- Vector control not practical on a large scale.

### **Inactivated vaccines:**

- Have been used widely in India and Europe in last 10 years;
- Safe and effective but little cross protection between serotypes



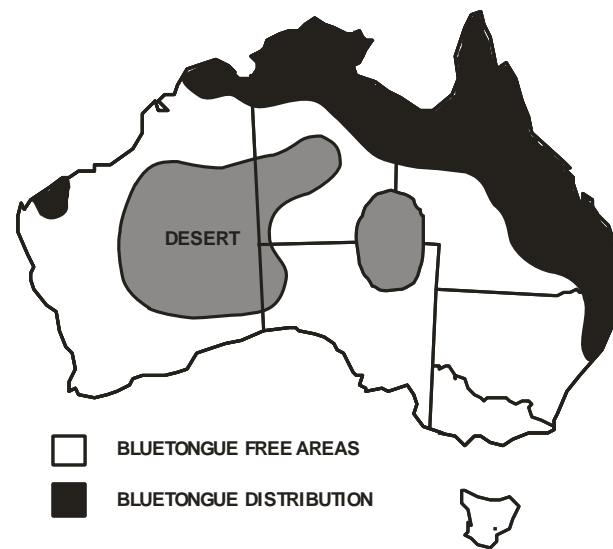
## Distribution of Bluetongue viruses in Australia

- Natural distribution of viruses determined solely by distribution of insect vector;
- BTVs transmitted exclusively by biting midges – *Culicoides* species;
- In eastern Australia (NSW & southern Qld), *Culicoides brevitarsis*
- In northern Australia, especially the ‘Top End’ of NT, *C. brevitarsis* and additional tropical vectors (*C. actoni*, *fulvus*, *wadai*).



# Bluetongue virus epidemiology

- Geographical distribution of bluetongue virus in Australia may be similar to (but never exceed) the distribution of principal vector, *Culicoides brevitarsis*;



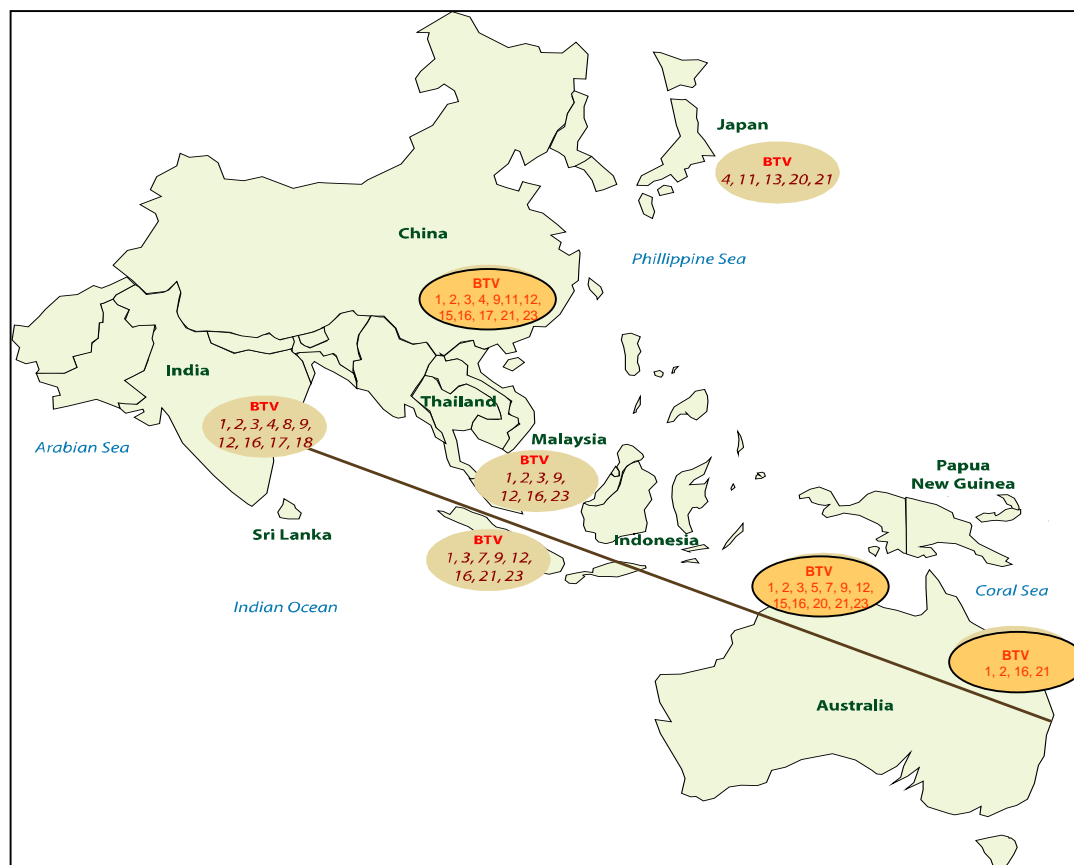
## Trends in the Australasian region

- Considered to be an evolving episystem;
- Viruses moving from equatorial regions to the north and south



## Trends in the Australasian region

- Recent incursions of BTV 2, 5, 7 & 12 into Australia;
- Evidence of exchange of genotypes (within a serotype) between Australia and southern Asia;
- Will other serotypes move to Australia or the Asian region??





# Bluetongue virus surveillance

- Vector distribution and virus transmission patterns established;
- Research projects for virus-vector surveillance resulted in the development of the National Arbovirus Monitoring Program (NAMP)
- Vector-borne viruses have been systematically monitored for >30 years



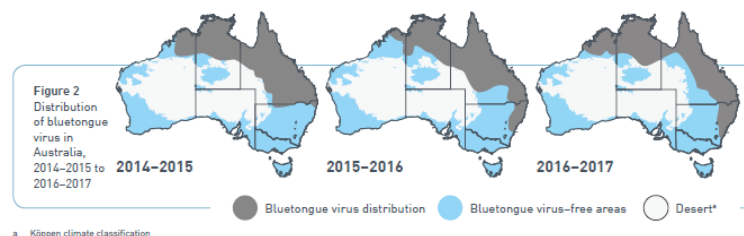


## What is NAMP and how is it managed?

- NAMP is a nationally co-ordinated program for the monitoring of selected vector-borne viruses of importance to animal health in Australia
- The monitoring program is managed by a group representing state and federal governments and the major livestock industries and co-ordinated by Animal Health Australia (AHA)
- AHA is a company owned by the livestock industries in partnership with the state and federal governments
- Operationally NAMP is managed by state co-ordinators

## What are the objectives?

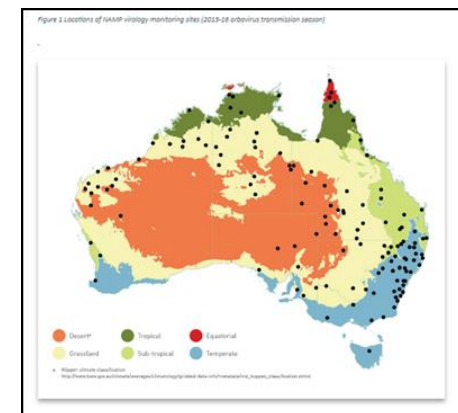
- Market access – to facilitate the export of live cattle, sheep and goats, and ruminant genetic material, to countries with concerns about bluetongue, Akabane and bovine ephemeral fever (BEF) viruses
- Bluetongue early warning – to detect incursions of exotic strains of bluetongue virus (BTV) and vectors (*Culicoides* species biting midges) into Australia by surveillance of the northern BTV epidemic area
- Risk management – to detect changes in the seasonal distribution in Australia of endemic bluetongue, Akabane and BEF viruses and their vectors, to support livestock exporters



# Bluetongue virus monitoring.

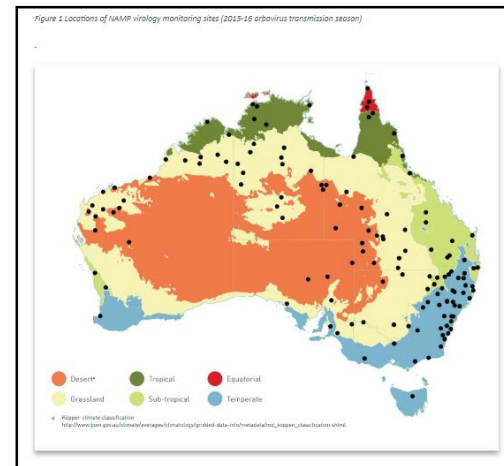
## Bluetongue virus and vector surveillance in Australia:

- Sentinel herds strategically located in BTV free and zone of possible transmission
- Vector collection at same locations
- Virology and entomology done in state laboratories
- Centralised data collection – internet submission
- Virus submitted for centralised sequencing and molecular topotyping



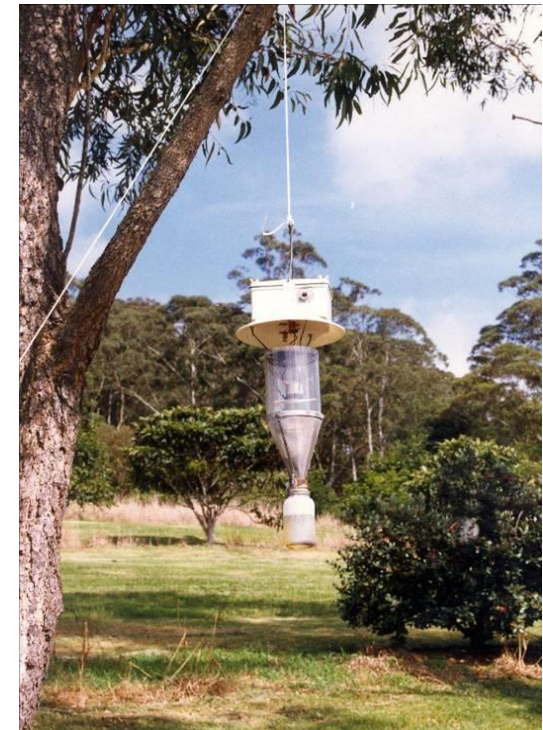
# How and where is monitoring conducted?

- Groups of young cattle (sentinel herds) are strategically located around Australia throughout the known range of the principal *Culicoides* species
- Serosurveillance herds
- Insects are collected in light traps



## What testing is carried out?

- 10-15 animals (6-9 mths in spring)
- Blood samples collected regularly (monthly in coastal locations – weekly at CPRS, NT)
- Synchronised sampling between sites
- Tested for Akabane (Simbu serogroup), Bluetongue and Ephemeral Fever virus antibodies – ELISA and VNT
- BTV PCR (Pan); serotyping by PCR or VNT
- Bluetongue virus isolation – ID of serotype and topotype
- *Culiocoides* midges sorted to species





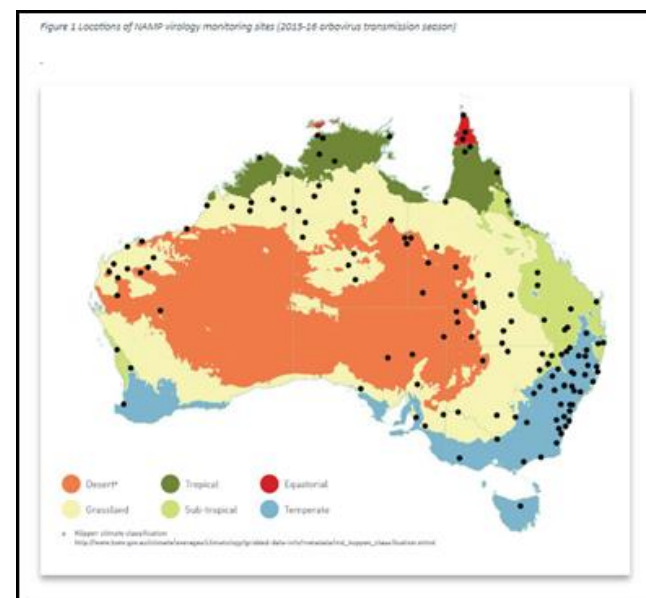
# Example of sentinel herd results

## PATERSON - BLUETONGUE VIRUS - ELISA (2016/17)

ANIMAL	EARTAG	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	END
1	1619	-		-	-	-	-	85+	90+	93+	93+	95+
2	1620	-		-	-	-	-	95+	94+	88+	92+	90+
3	1621	-			-	-	-	-	91+	92+	93+	97+
4	1622	96+		94+	95+	96+	92+	94+	93+	88+	95+	91+
5	1624	-		-		-	-	86+	88+	77+	91+	96+
6	1625	-			-	-	-	92+	92+	93+	83+	94+
7	1626	-		-	-	-	-	91+	93+	93+	91+	95+
8	1627	-		-	-	-	-	65?	92+	92+	90+	95+
9	1629	-		-	-	-	-	91+	93+	84+	90+	95+
10	1630	60?		-	-	-	-	92+	93+	91+	71+	96+
<b>At Risk (A)</b>		8		6	8	9	9	9	1	0	0	0
<b>No S/C (S)</b>		0		0	0	0	0	8	1	0	0	0
<b>TOTAL (T)</b>		10		8	9	10	10	10	10	10	10	10

## PATERSON - BLUETONGUE VIRUS - PAN PCR (2016/17)

ANIMAL	EARTAG	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	END
1	1619	NT		NT	NT	NT	-	33.4	31.4	33.7	-	NT
2	1620	NT		NT	NT	NT	-	32.6	31.7	33.9	-	NT
3	1621	NT			NT	NT	-	32.2	30.3	32.2	32.8	NT
4	1622	NT		NT	NT	NT	-	31.1	29.9	28.8	30.4	NT
5	1624	NT		NT		NT	-	26.9	27.6	28.9	30.9	NT
6	1625	NT			NT	NT	-	33.4	33.8	34.3	-	NT
7	1626	NT		NT	NT	NT	-	32.6	31.5	31.9	33.4	NT
8	1627	NT		NT	NT	NT	-	28.6	28.4	29.4	32.6	NT
9	1629	NT		NT	NT	NT	-	34.9	30.7	29.9	32.0	NT
10	1630	NT		NT	NT	NT	-	31.5	29.4	32.1	33.0	NT
<b>At Risk (A)</b>		8		6	8	9	9	9	1	0	0	0
<b>No S/C (S)</b>		0		0	0	0	0	8	1	0	0	0
<b>TOTAL (T)</b>		10		8	9	10	10	10	10	10	10	10



# Example of sentinel herd results

**PATERSON - BTV1 PCR (2016/17)**

ANIMAL	EARTAG	MAR	APR	MAY	JUN	JUL	END
1	1619	NT	35.8	38.1	-	NT	NT
2	1620	NT	32.9	38.1	-	NT	NT
3	1621	NT	32.8	37.7	-	-	NT
4	1622	NT	32.2	36.0	34.3	32.3	NT
5	1624	NT	-	39.0	-	-	NT
6	1625	NT	-	-	36.9	NT	NT
7	1626	NT	33.9	-	-	-	NT
8	1627	NT	-	34.4	33.8	34.8	NT
9	1629	NT	-	-	-	-	NT
10	1630	NT	33.0	35.8	-	-	NT
<b>At Risk (A)</b>		9	9	1	0	0	0
<b>No S/C (S)</b>		0	8	1	0	0	0
<b>TOTAL (T)</b>		10	10	10	10	10	10

**PATERSON - BTV21 PCR (2016/17)**

ANIMAL	EARTAG	MAR	APR	MAY	JUN	JUL	END
1	1619	NT	-	-	-	NT	NT
2	1620	NT	-	38.0	-	NT	NT
3	1621	NT	-	-	-	-	NT
4	1622	NT	36.7	-	36.1	-	NT
5	1624	NT	-	-	-	-	NT
6	1625	NT	-	-	34.6	NT	NT
7	1626	NT	-	33.1	30.7	-	NT
8	1627	NT	31.3	30.3	30.3	37.6	NT
9	1629	NT	35.6	31.6	32.5	31.9	NT
10	1630	NT	-	31.4	-	36.2	NT
<b>At Risk (A)</b>		9	9	1	0	0	0
<b>No S/C (S)</b>		0	8	1	0	0	0
<b>TOTAL (T)</b>		10	10	10	10	10	10

**PATERSON - BTV16 PCR (2016/17)**

ANIMAL	EARTAG	MAR	APR	MAY	JUN	JUL	END
1	1619	NT	-	-	-	NT	NT
2	1620	NT	-	-	-	NT	NT
3	1621	NT	-	-	-	-	NT
4	1622	NT	-	-	-	-	NT
5	1624	NT	29.0	30.3	31.9	31.9	NT
6	1625	NT	35.7	36.6	40	NT	NT
7	1626	NT	-	-	-	-	NT
8	1627	NT	-	-	-	-	NT
9	1629	NT	-	-	-	-	NT
10	1630	NT	-	-	-	-	NT
<b>At Risk (A)</b>		9	9	1	0	0	0
<b>No S/C (S)</b>		0	8	1	0	0	0
<b>TOTAL (T)</b>		10	10	10	10	10	10



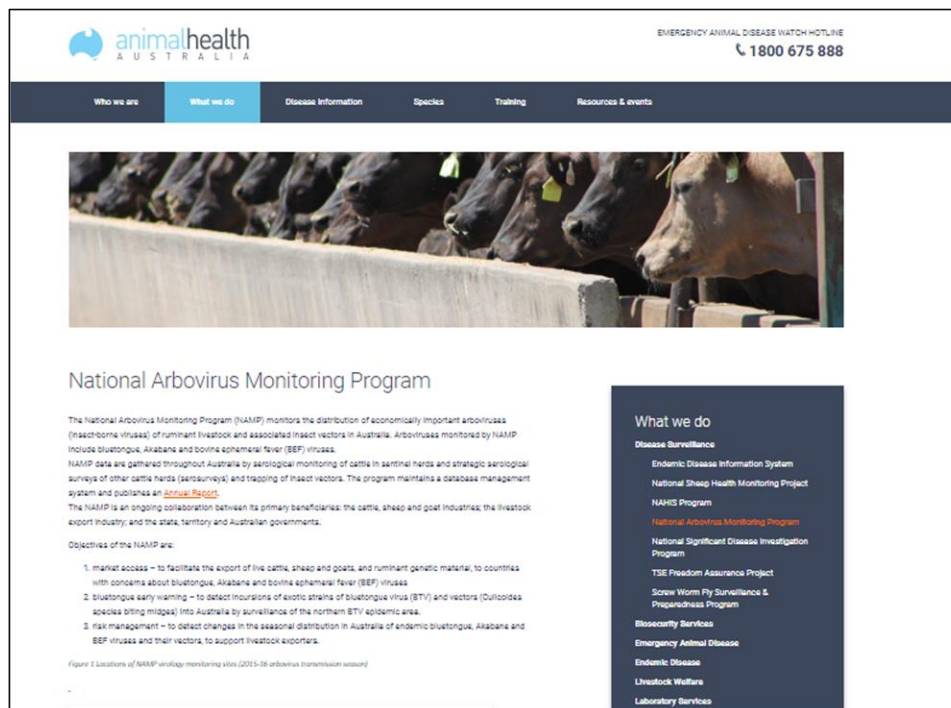


# Bluetongue virus epidemiology

- Monitoring of sentinel cattle demonstrates intermittent transmission of bluetongue viruses within range of *C. brevitarsis*
- Consistent north-south transmission pattern & southern limit of spread
- Virus isolation & qRT-PCR identify serotypes that are active
- Nucleic acid sequencing demonstrates genetic variation in strains within a serotype – confirms incursions and reassortment of BTV genes

# Management of NAMP data

- AHA website
- Unique property identifiers
- Web-based data submission – interactive error checking



animalhealth AUSTRALIA

EMERGENCY ANIMAL DISEASE WATCH HOTLINE  
1800 675 888

Who we are What we do Disease Information Species Training Resources & events

**National Arbovirus Monitoring Program**

The National Arbovirus Monitoring Program (NAMP) monitors the distribution of economically important arboviruses (naectborne viruses) of ruminant livestock and associated insect vectors in Australia. Arboviruses monitored by NAMP include bluetongue, Akabane and bovine ephemeral fever (BEF) viruses. NAMP data are gathered throughout Australia by serological monitoring of cattle in sentinel herds and strategic serological surveys of other cattle herds (sarsurveys) and trapping of insect vectors. The program maintains a database management system and publishes an [Annual Report](#).

The NAMP is an ongoing collaboration between its primary beneficiaries: the cattle, sheep and goat industries; the livestock export industry; and the state, territory and Australian governments.

Objectives of the NAMP are:

1. market access – to facilitate the export of live cattle, sheep and goats, and ruminant genetic material, to countries with concerns about bluetongue, Akabane and bovine ephemeral fever (BEF) viruses.
2. bluetongue early warning – to detect incursions of exotic strains of bluetongue virus (BTV) and vectors (*Culicoides* species biting midges) into Australia by surveillance of the northern BTV endemic area.
3. risk management – to detect changes in the seasonal distribution in Australia of endemic bluetongue, Akabane and BEF viruses and their vectors, to support livestock exporters.

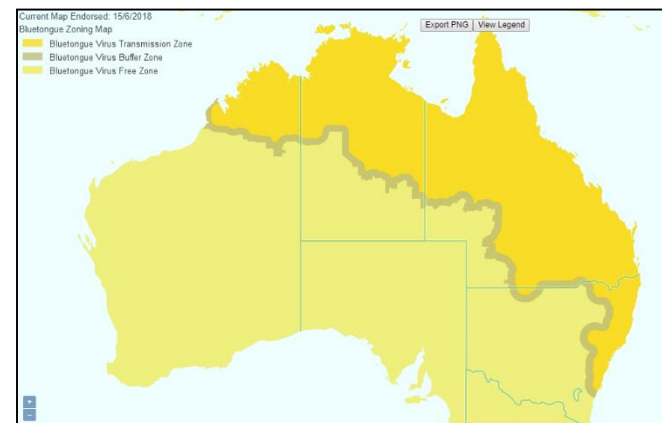
Figure 1 Locations of NAMP serology monitoring sites (2015-16 arbovirus transmission season)

**What we do**

- Disease Surveillance
  - Endemic Disease Information System
  - National Sheep Health Monitoring Project
  - NAHS Program
  - National Arbovirus Monitoring Program
  - National Significant Disease Investigation Program
  - TSE Freedom Assurance Project
  - Scree Worm Fly Surveillance & Preparedness Program
- Biosecurity Services
  - Emergency Animal Disease
  - Endemic Disease
  - Livestock Welfare
  - Laboratory Services


## Changes of the Bluetongue zones in Australia

- BTV zone defined by composite distribution of viruses in previous 2 years
- A location must be BTV free continuously for 2 years to effect a change of status
- Detection of BTV in a free sentinel herd activates immediate notification, investigation and change of status if BTV confirmed;
- Zone map changed and notification by email to exporters or anyone registered to receive notification of changes;



# Outputs from NAMP

- BTV zone maps (interactive and GIS format)
- Zone maps dynamic, auto-notification system
- Synoptic annual reports



The screenshot displays the NAMP website interface. At the top left is the Animal Health Australia logo. The main header includes the NAMP logo and the text "National Arbovirus Monitoring Program". A navigation bar contains links for "AHA Home", "NAMP Program", and "Annual NAMP Report".

The main content area is titled "Blue Tongue Virus Zone Map". It contains a paragraph explaining that NAMP data is gathered throughout Australia by serological monitoring of cattle in sentinel herds, strategic serological surveys of cattle herds, and trapping of insect vectors, used to develop the blue tongue virus zone map. It also states that the map defines the area where blue tongue virus is considered to occur and the area where no occurrence has been detected for at least two years.


An "Important notice" section follows, stating that the map is updated throughout the year in response to new monitoring information and is subject to change without notice. It advises that State or Territory government NAMP coordinators (contact officers) should be consulted for local information on the occurrence of blue tongue virus and requirements for trade and certification. A list of contact officers and contact details are supplied in the [Annual NAMP Report](#).

Below the notice is a checkbox:  I have read and understand this notice and accept the information advised in this notice. A "View Zone Map" button is located below the checkbox.

On the right side of the page is a "NAMP Database Management System Program Personnel Login" form. It includes fields for "Username:" and "Password:", a "Login" button, and a "Conditions of use" section with the text: "Forgotten your password? Please contact the Administrator or call 0262286200."

# Availability of NAMP data

- BTV zone maps and reports available on line

 **NAMP**  
National Arbovirus Monitoring Program

[AHA Home](#) | [NAMP Program](#) | [Annual NAMP Report](#)

### Bluetongue Zoning Maps

Current map endorsed: 15/6/2018

[Browse Interactive Map](#)

Opens an interactive map that allows you to zoom in and show more detail down to the property level

[Download map in GIS format](#)

Download the current zoning boundaries in ESRI shapefile format compressed as a zip file. To view these maps, you will need software capable of displaying shapefiles, such as ArcExplorer (available free from the [ESRI website](#)).

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### Notification of Zone Map Changes

To receive automated notification of changes to the bluetongue zone map, enter your email address below.

Email addresses will not be used for any other purpose than notifying users of zone map changes, and will not be made available to any other organisation. [Click here](#) for information on Animal Health Australia's privacy policy.




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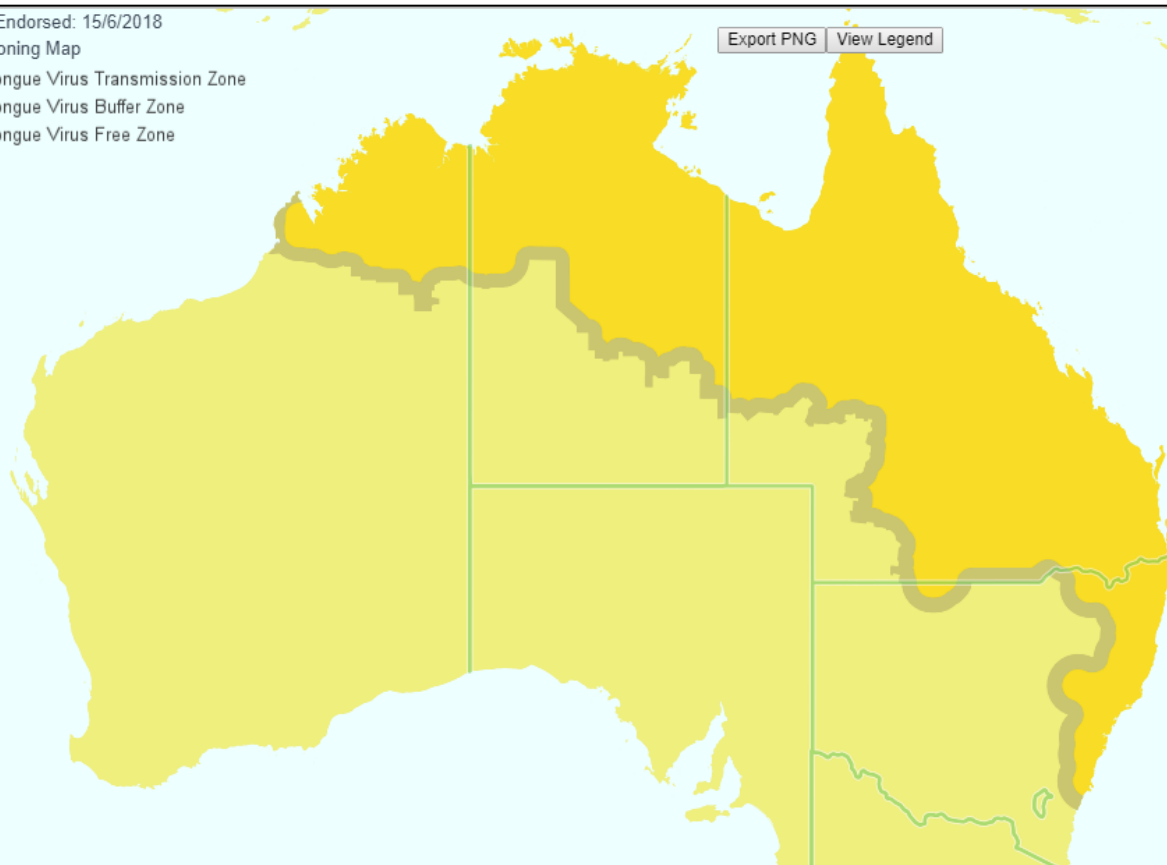


# BTV Zone – Interactive Map

Current Map Endorsed: 15/6/2018  
Bluetongue Zoning Map

Export PNG View Legend

-  Bluetongue Virus Transmission Zone
-  Bluetongue Virus Buffer Zone
-  Bluetongue Virus Free Zone



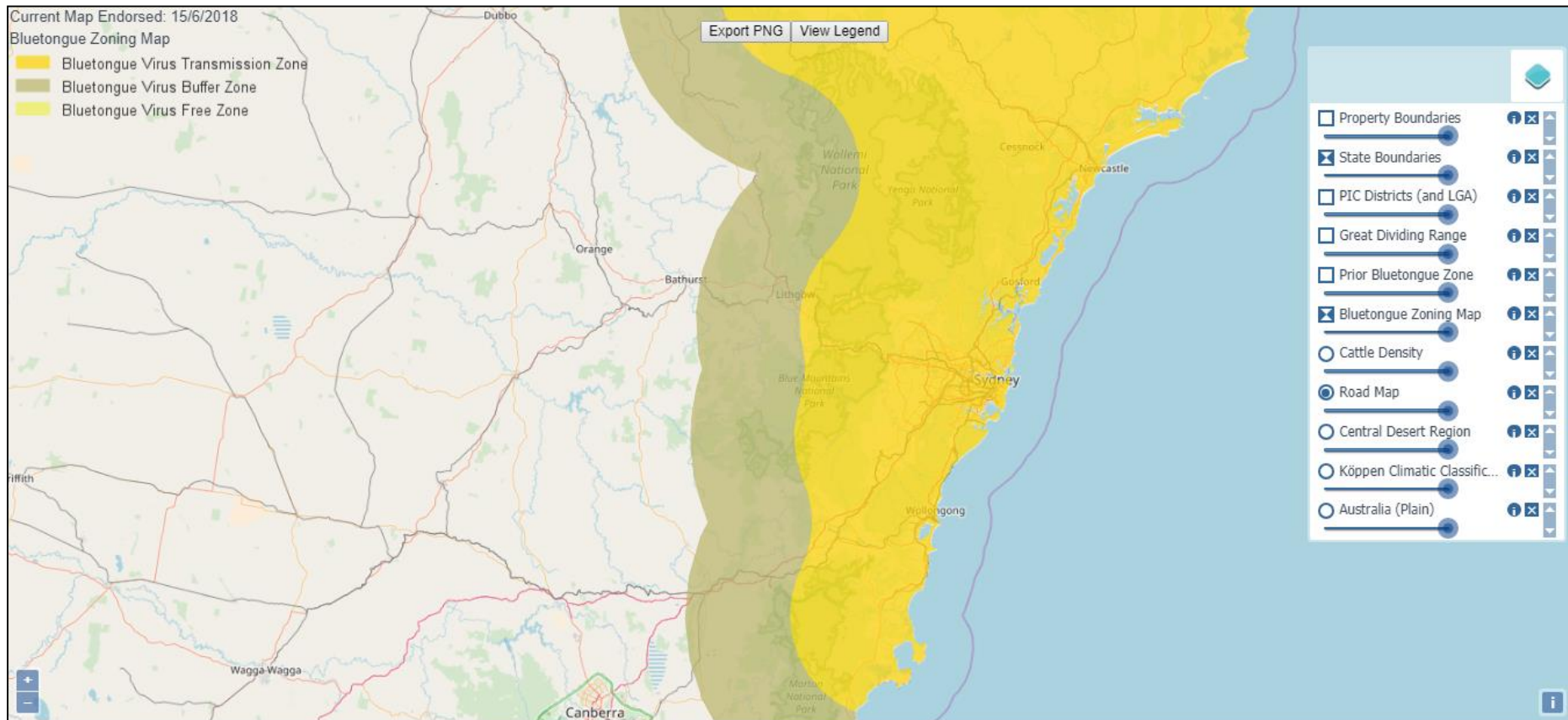
- Property Boundaries
- State Boundaries
- PIC Districts (and LGA)
- Great Dividing Range
- Prior Bluetongue Zone
- Bluetongue Zoning Map
- Sheep Density
- Cattle Density
- Road Map
- Central Desert Region
- Köppen Climatic Classific...
- Australia (Plain)





# BTV free zones – interactive

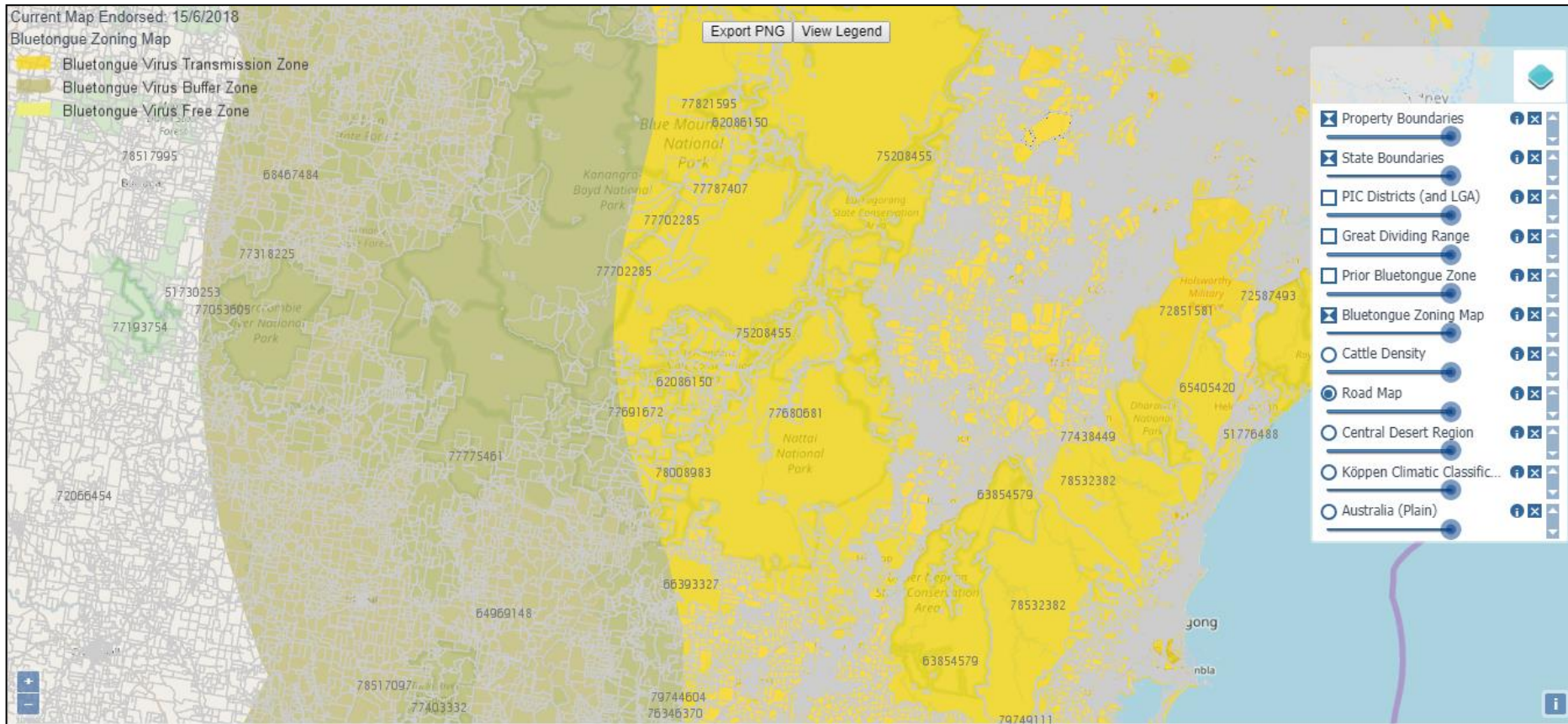
NAMP data can be used to identify BTV boundaries





# BTV free zones – interactive

Interactive map can be used to determine if property in or out of BTV free zone



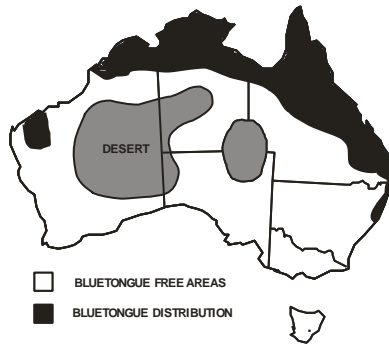




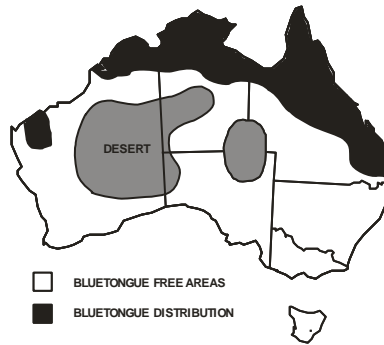
# Bluetongue virus epidemiology

- Annual transmission patterns regular and 'predictable' - nationally

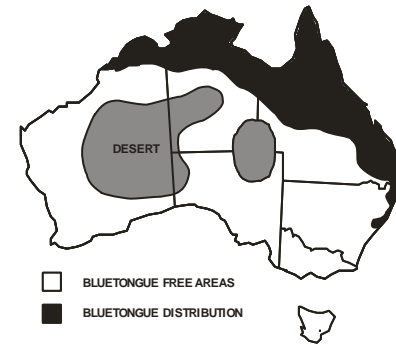
LIMITS OF BLUETONGUE VIRUS 2002/2003



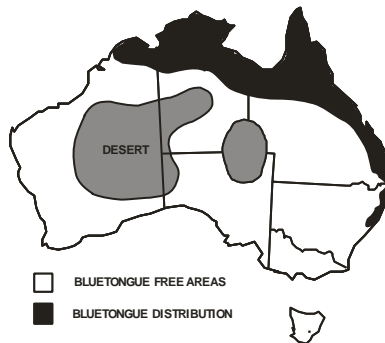
LIMITS OF BLUETONGUE VIRUS 2003/2004



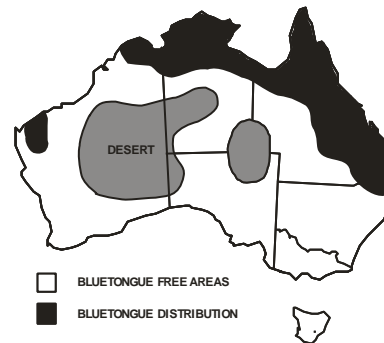
LIMITS OF BLUETONGUE VIRUS 2004/2005



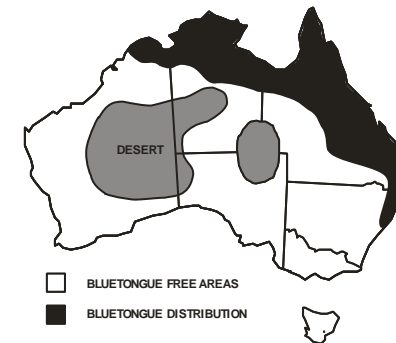
LIMITS OF BLUETONGUE VIRUS 2006/2007



LIMITS OF BLUETONGUE VIRUS 2007/2008



LIMITS OF BLUETONGUE VIRUS 2008/2009





## Bluetongue viruses – a summary

- Arboviruses – insect borne
- Vectors – only a few competent *Culicoides* species
- No vector - no spread
- No direct spread to animals by close contact



**Thank you for your attention**