

# Sub-national estimation of surveillance sensitivity to inform declaration of elimination

A retrospective validation against the elimination of wild poliovirus in Nigeria

Emily S Nightingale

IDM Symposium 2024

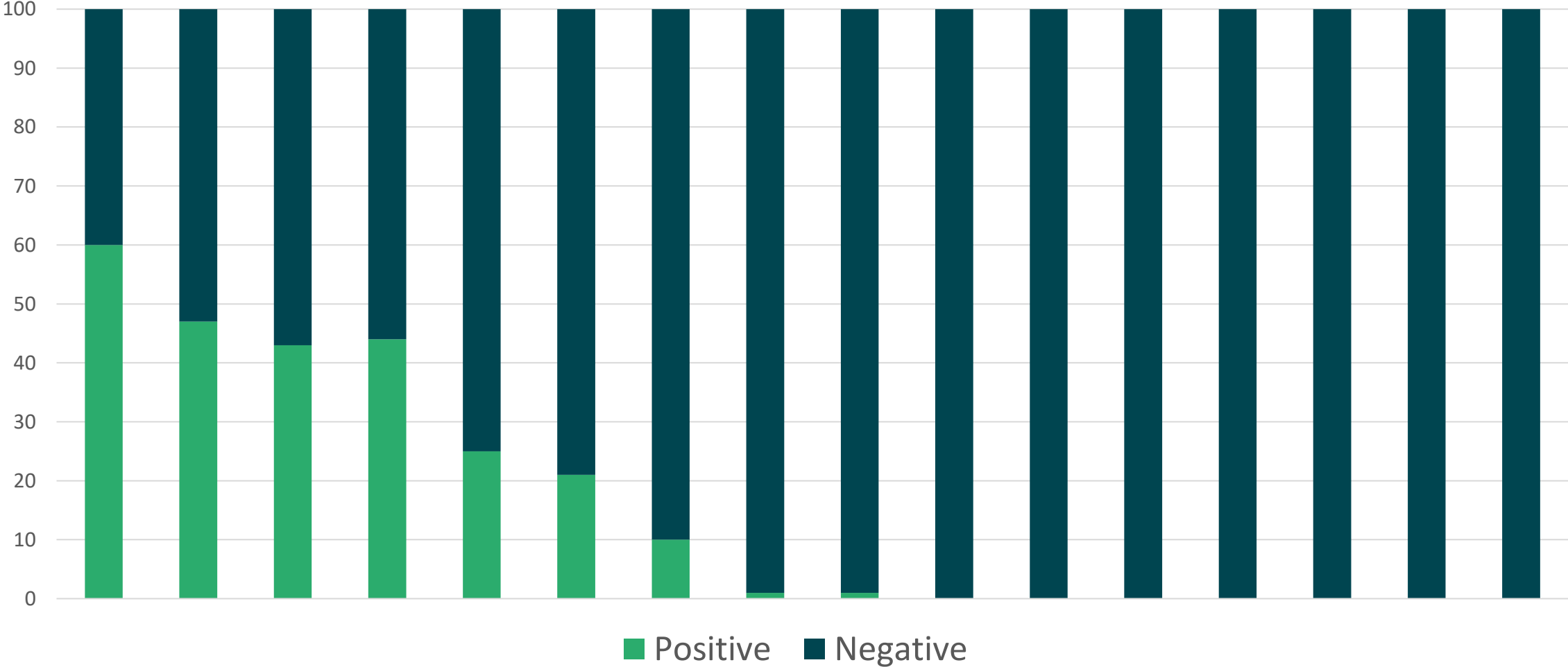
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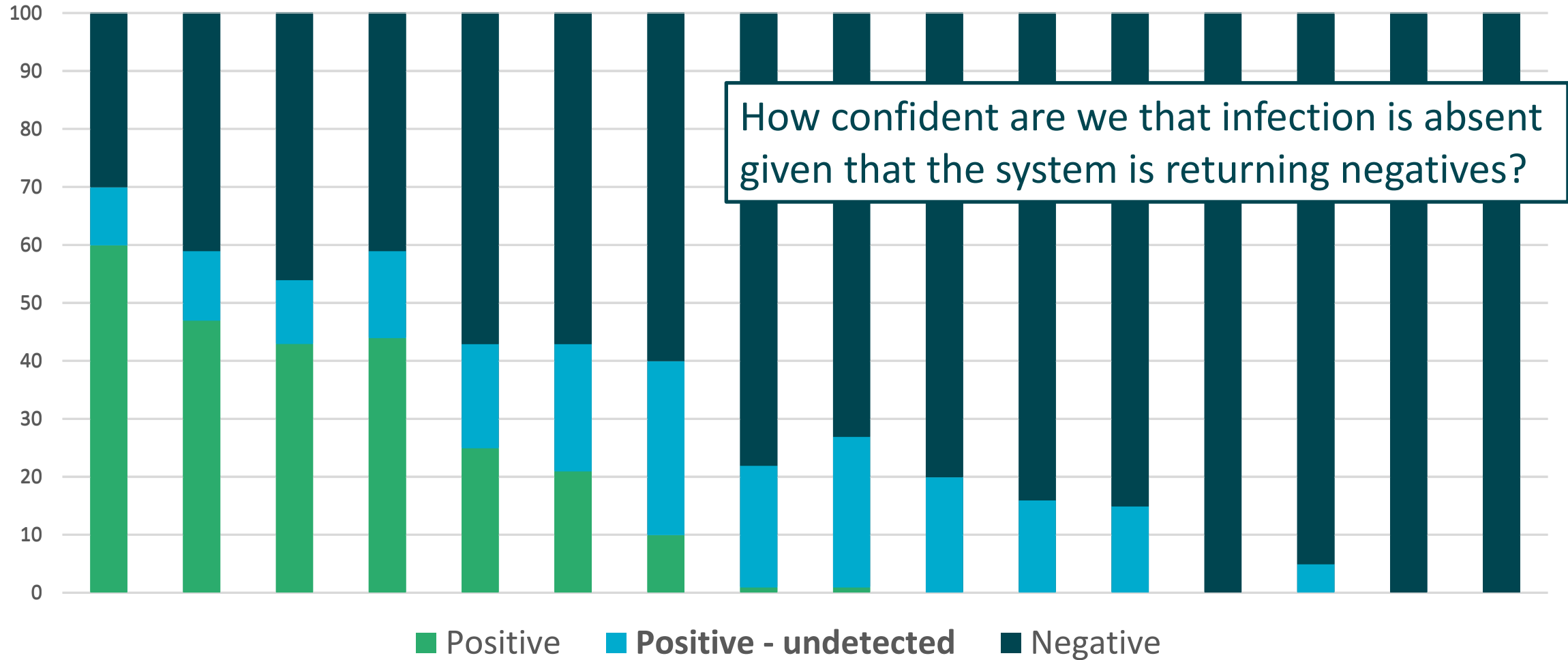
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# Near elimination, a surveillance system yields an increasing proportion of *negative* observations



# Near elimination, a surveillance system yields an increasing proportion of *negative* observations



How confident are we that infection is absent given the system is returning negatives?



This is the **negative predictive value** of the surveillance system

# How confident are we that infection is absent given the system is returning negatives?

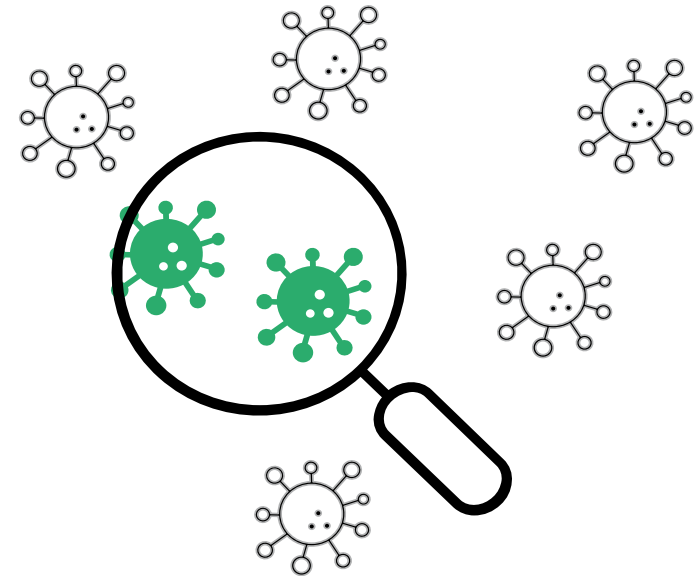


To infer this, we need to understand the **sensitivity** of the surveillance system for detecting infection

For polio, the surveillance system comprises of both *case-based* and *environmental* surveillance

Indicators of “performance” are routinely monitored, highlighting variability over time and space

➤ How can this be incorporated into interpretation?



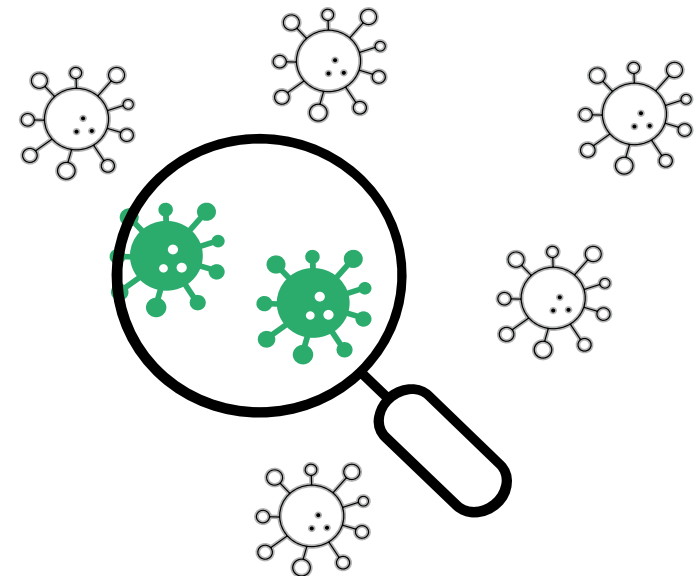
# How confident are we that infection is absent given the system is returning negatives?



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→ Extend an approach developed in animal health to model surveillance via scenario trees (*Martin et al. 2007*).



# Components of polio surveillance



## Acute Flaccid Paralysis

- Detect *symptomatic* infection in an individual
- Implemented nationally – all notified AFP cases tested



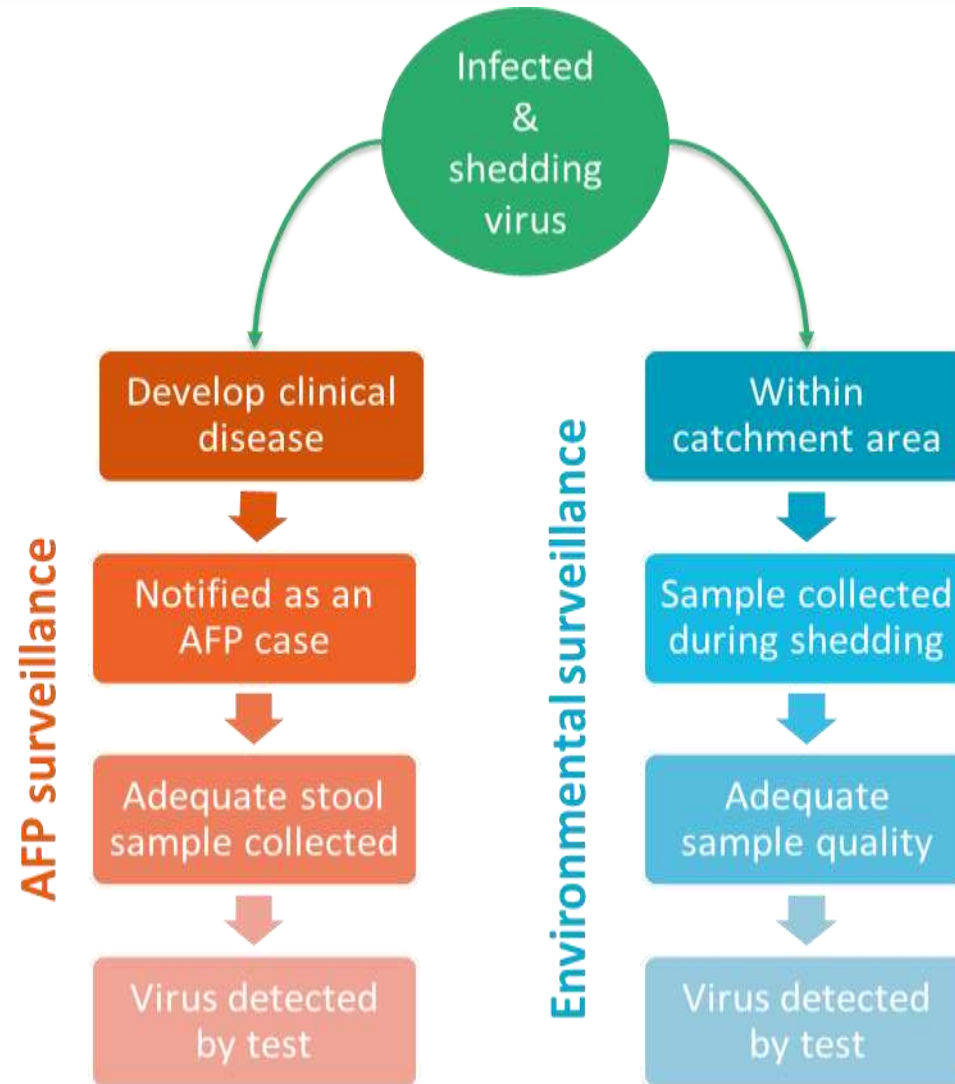
## Environmental

- Detect *symptomatic and asymptomatic* infection within catchment
- Limited population coverage





# Modelling surveillance sensitivity

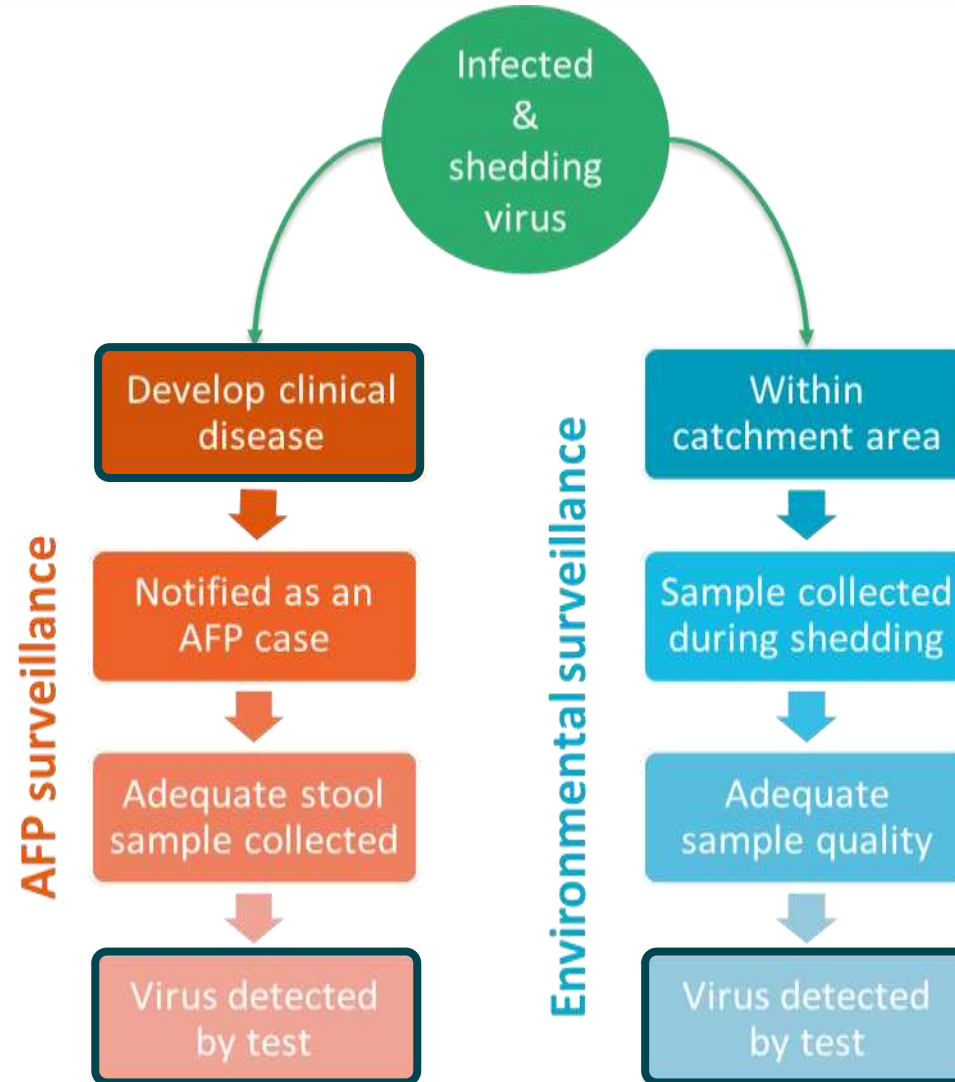


Probability that a single infection yields a positive outcome from the surveillance system



# Modelling surveillance sensitivity

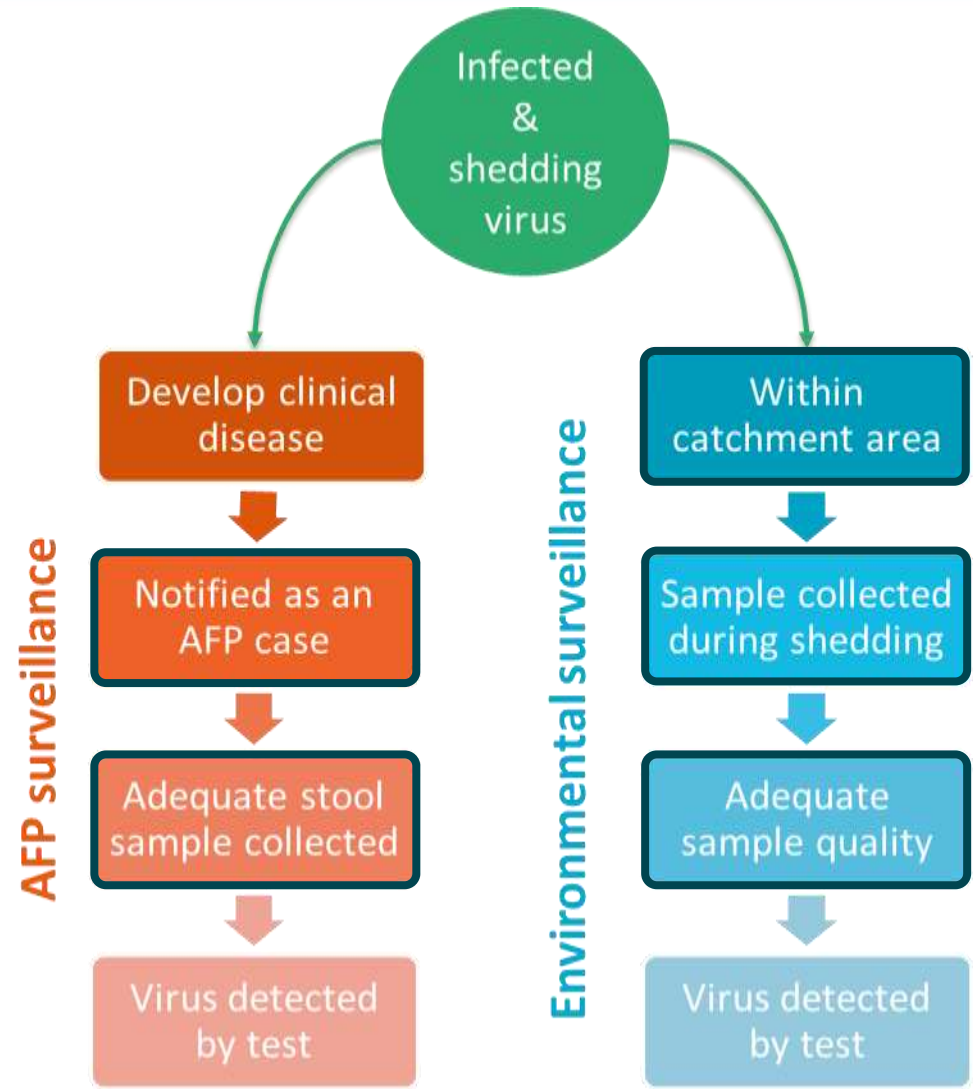
Fixed distribution assumed for these probabilities



Probability that a single infection yields a positive outcome from the surveillance system

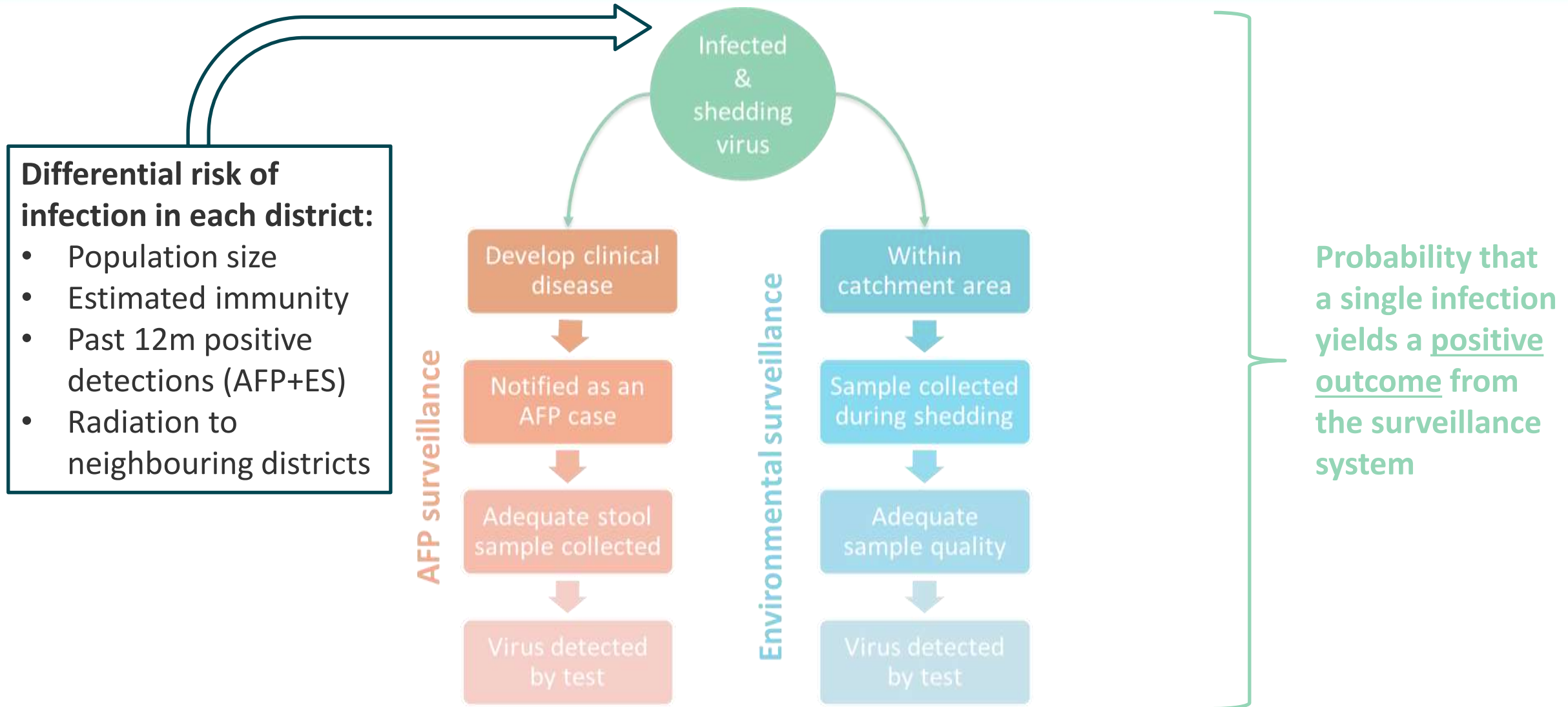
# Modelling surveillance sensitivity

Time-/district-dependent and data-informed estimation of these probabilities



Probability that a single infection yields a positive outcome from the surveillance system

# Modelling surveillance sensitivity



How low a prevalence does the surveillance system need to detect?

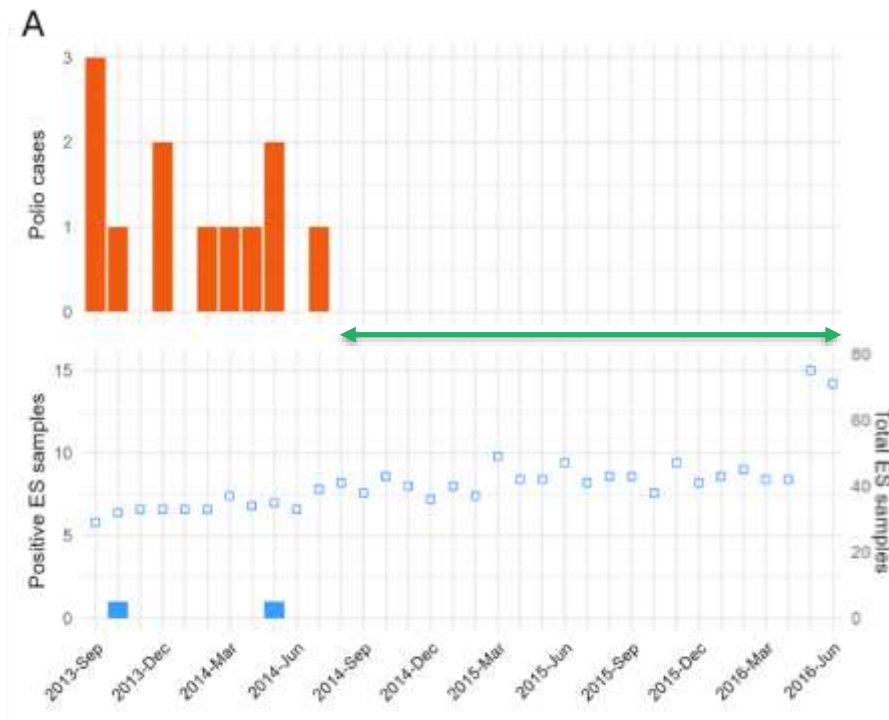
- Detecting lower prevalence demands higher sensitivity
- What prevalence do we expect near elimination?
- What prevalence is sufficient to interrupt transmission?

If the *country* is infected, we want sufficient sensitivity that infection is detected in **at least one district**.

If a *district* is infected, we want sufficient sensitivity to detect a **prevalence of 1 per 100,000**.

# Example: Elimination of WPV1 in Nigeria

WPV1 was not detected in *any* AFP stool or environmental sample between August 2014 and June 2016.

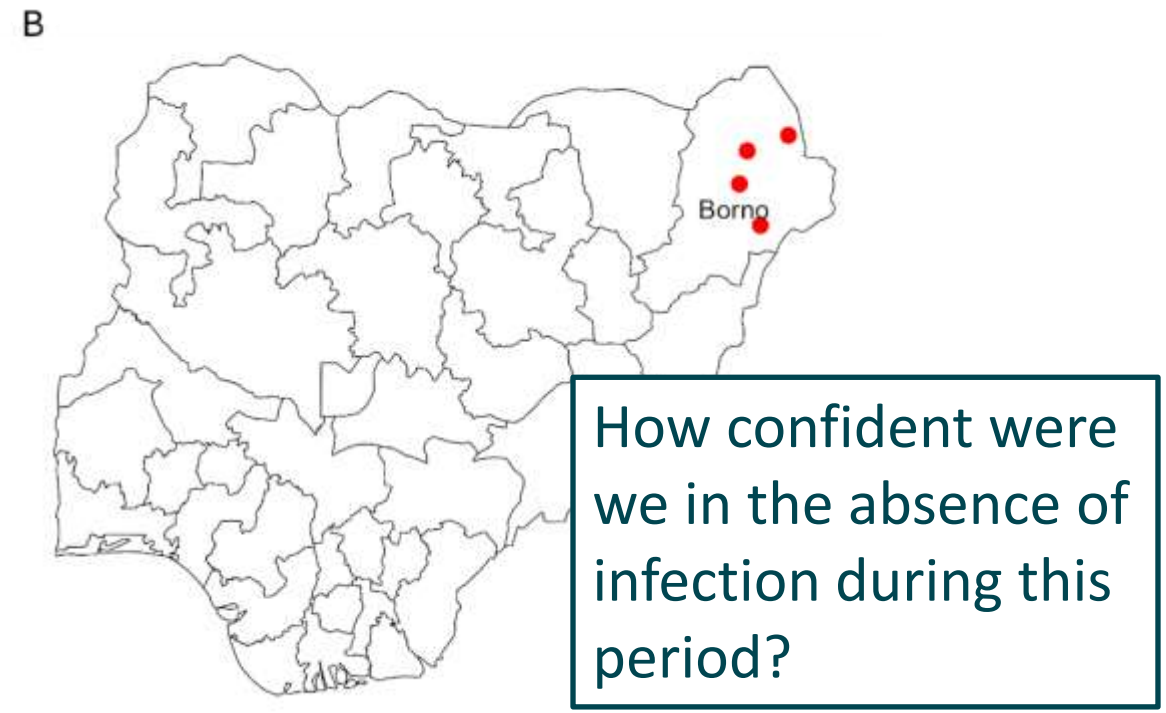
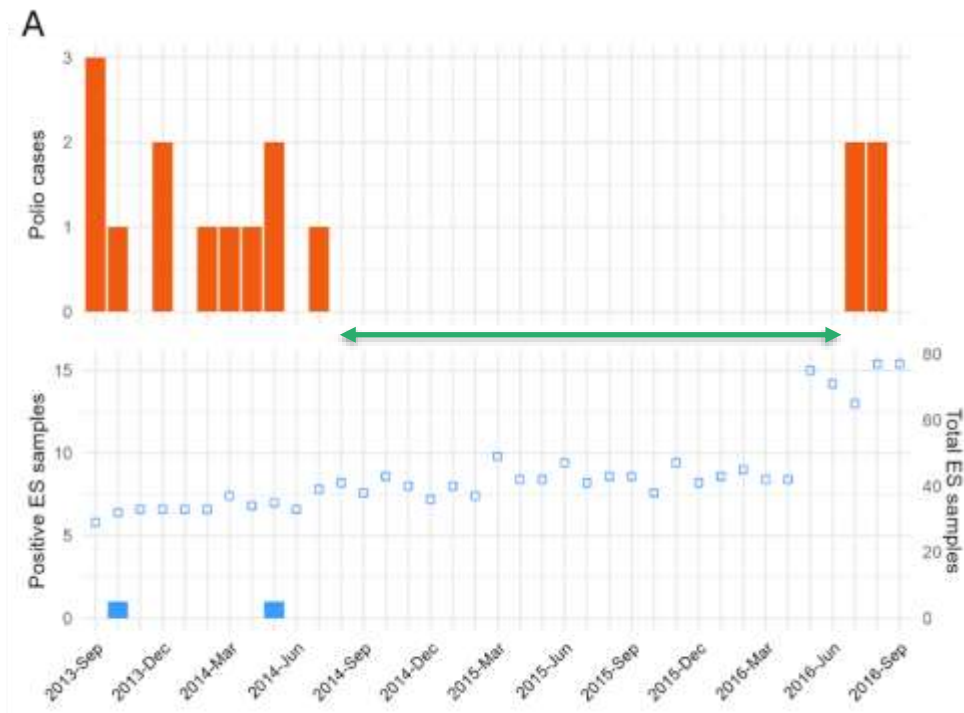


- **27,600** AFP cases notified
- **1,027** env. samples analysed  
*=> Zero positives*

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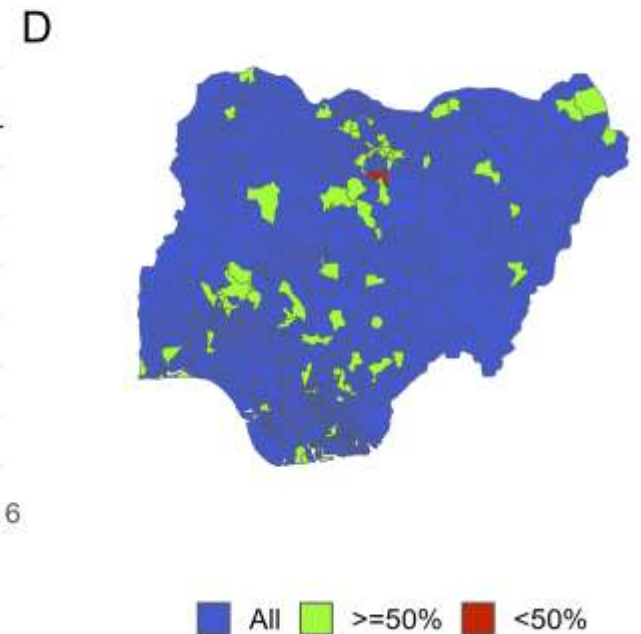
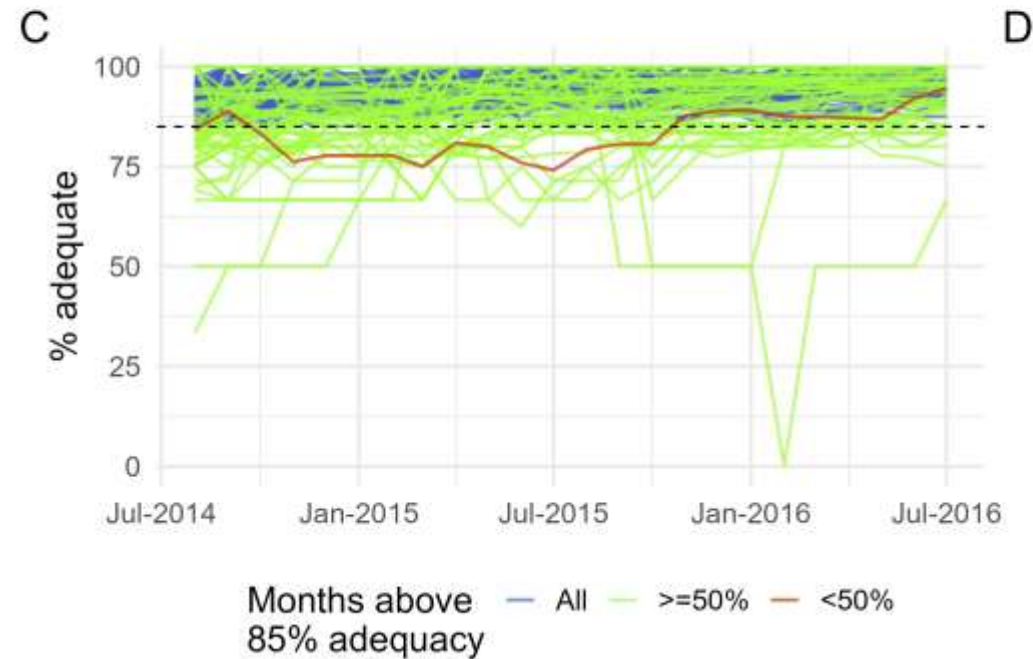
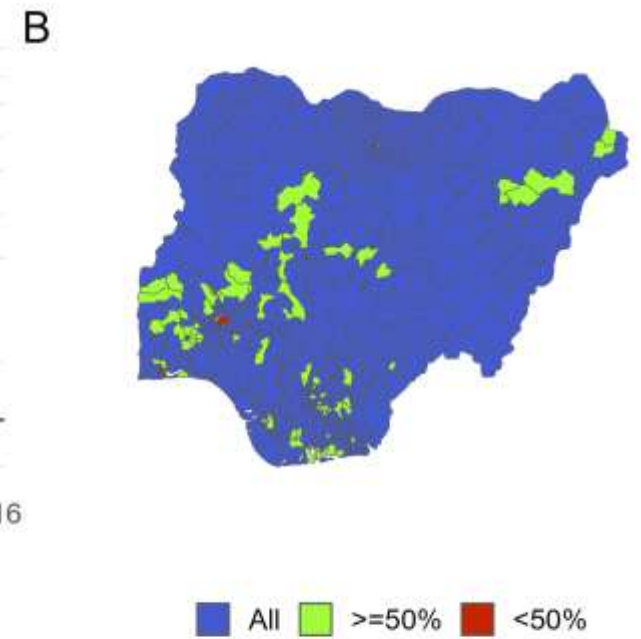
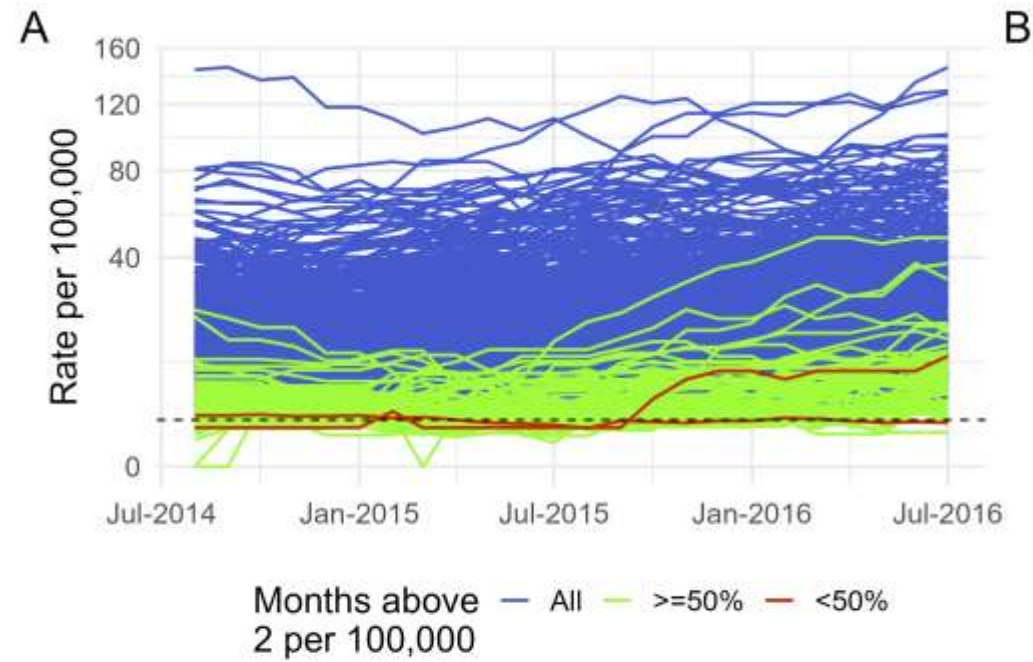
**In July 2016, four WPV1+ paralytic cases were detected in the northeastern state of Borno.**





# Surveillance performance: AFP

Across the majority of LGAs, WHO thresholds for **AFP reporting** and **stool adequacy** were consistently met/exceeded.

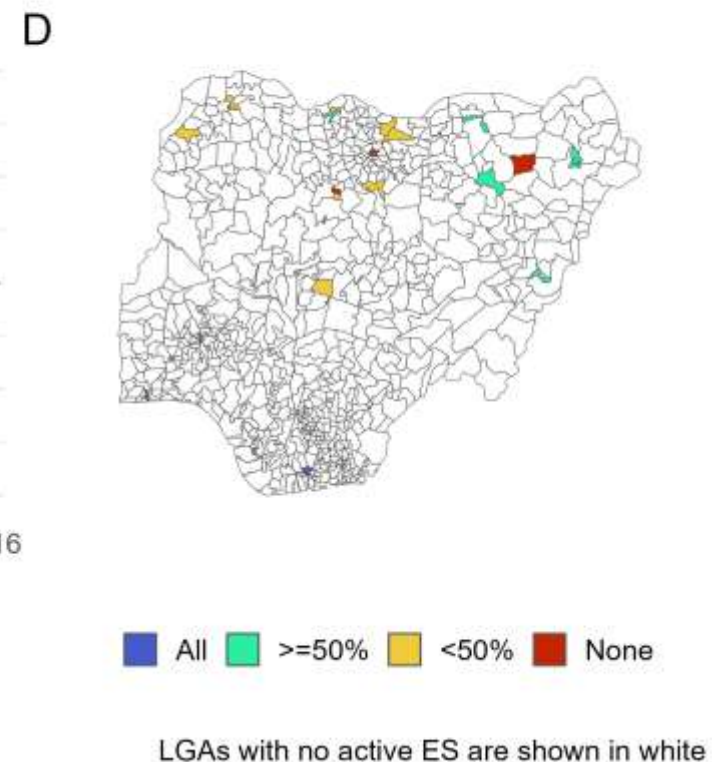
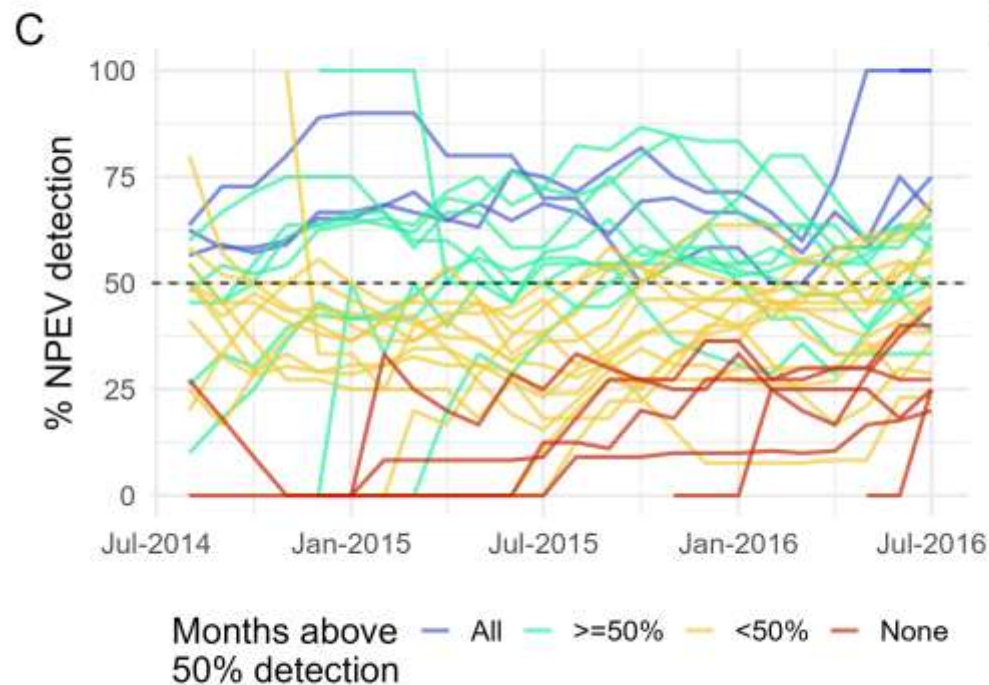
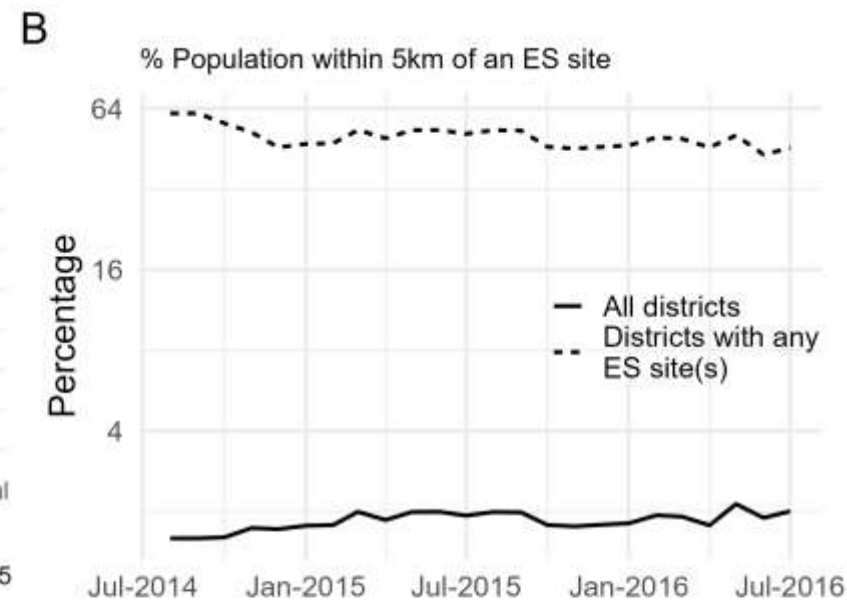
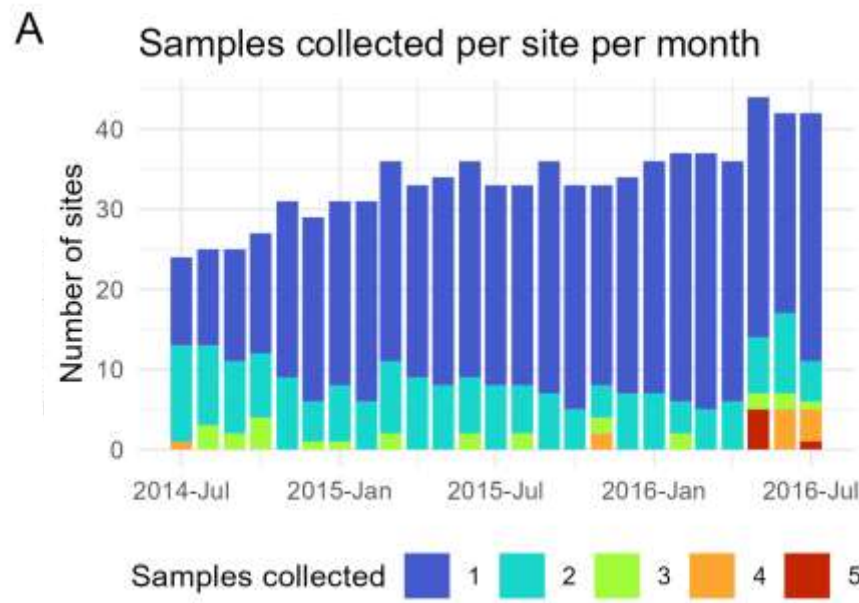




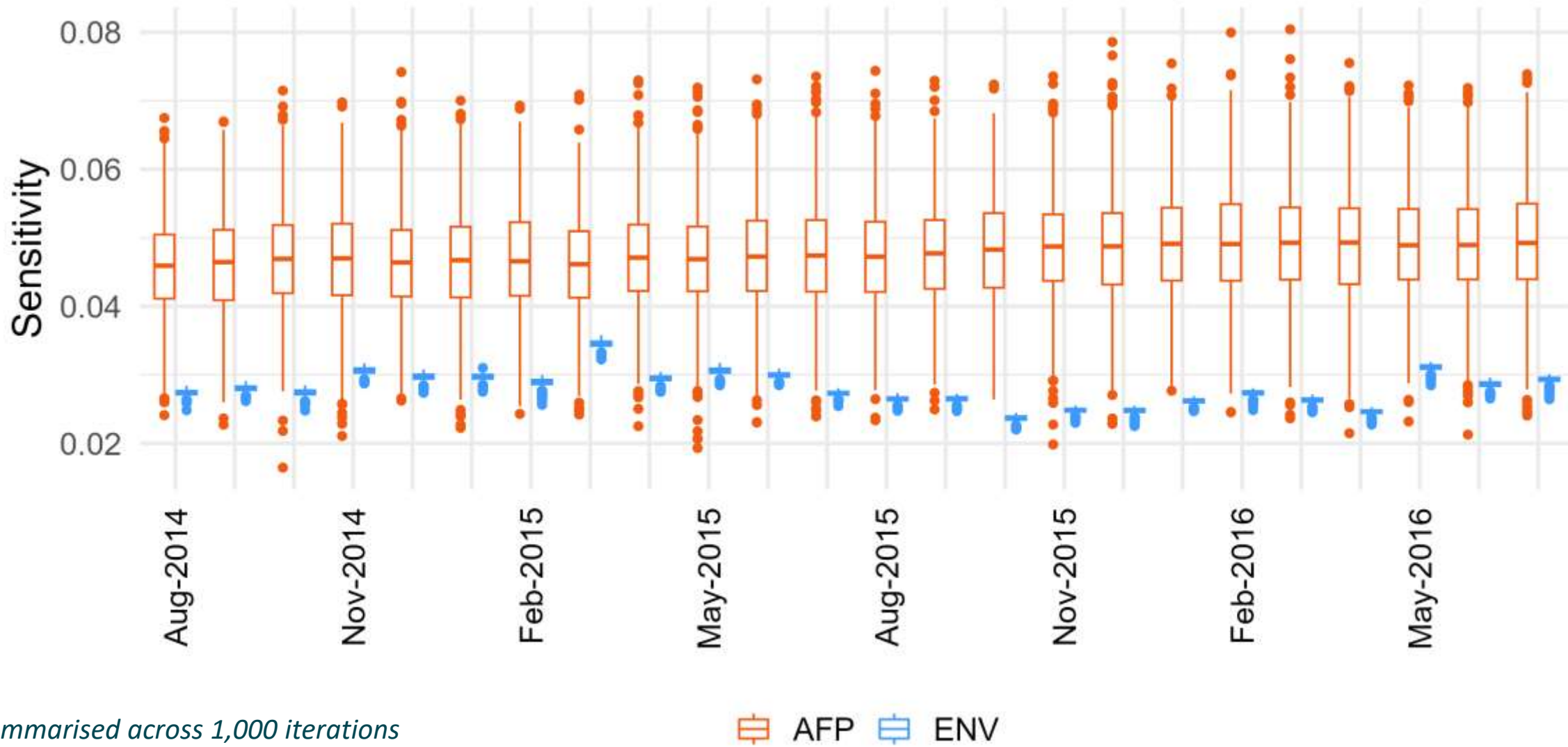
# Surveillance performance: Env

Despite overall expansion, **% LGA population within catchment** was low (~3%)

**Detection of non-polio enteroviruses (NPEV)** was adequate on average (~50%), but low in some LGAs

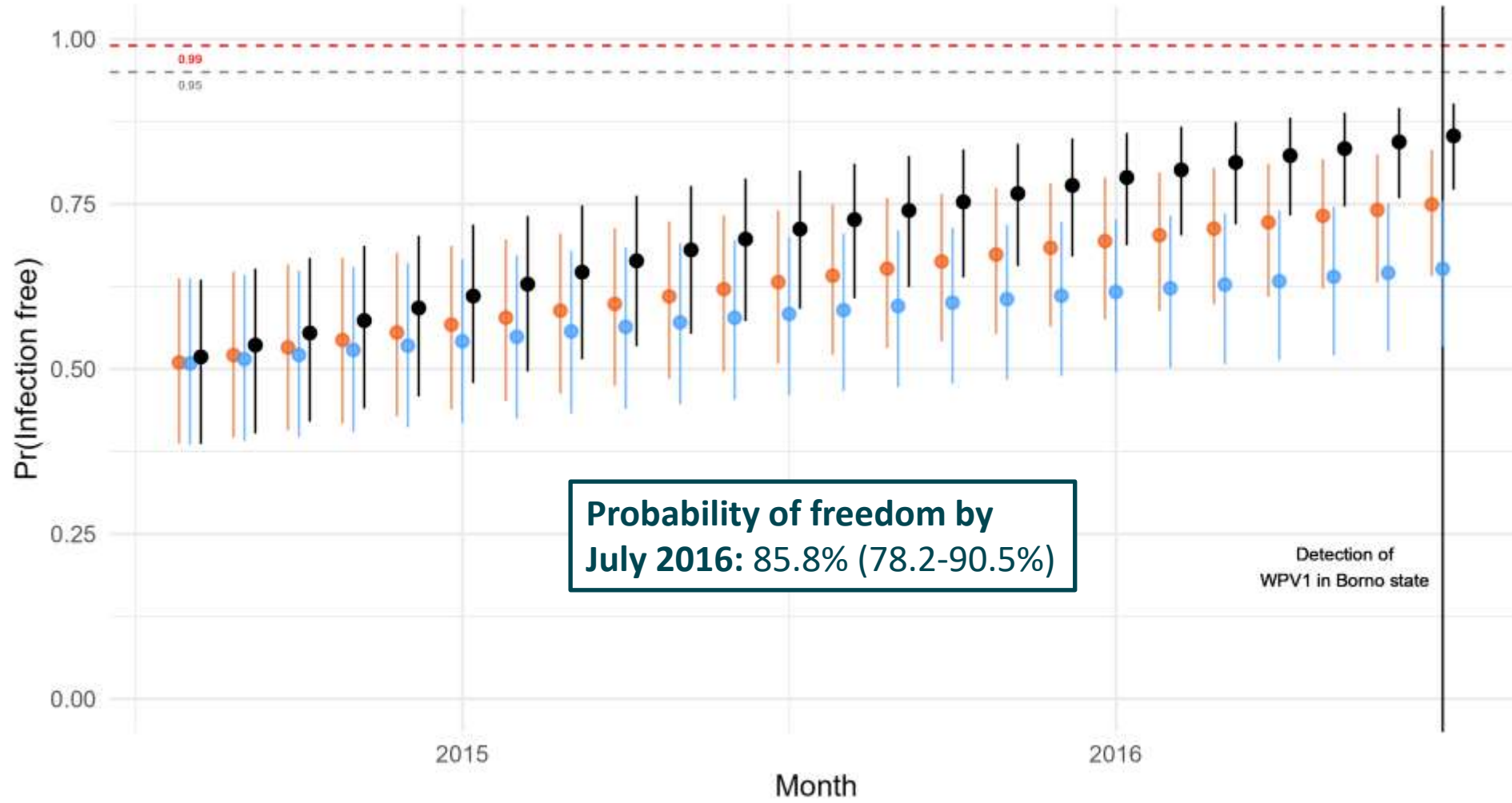


# Surveillance sensitivity over time



Summarised across 1,000 iterations

# Freedom from infection: 2014-2016



Mean and 95% quantile interval across 1,000 iterations

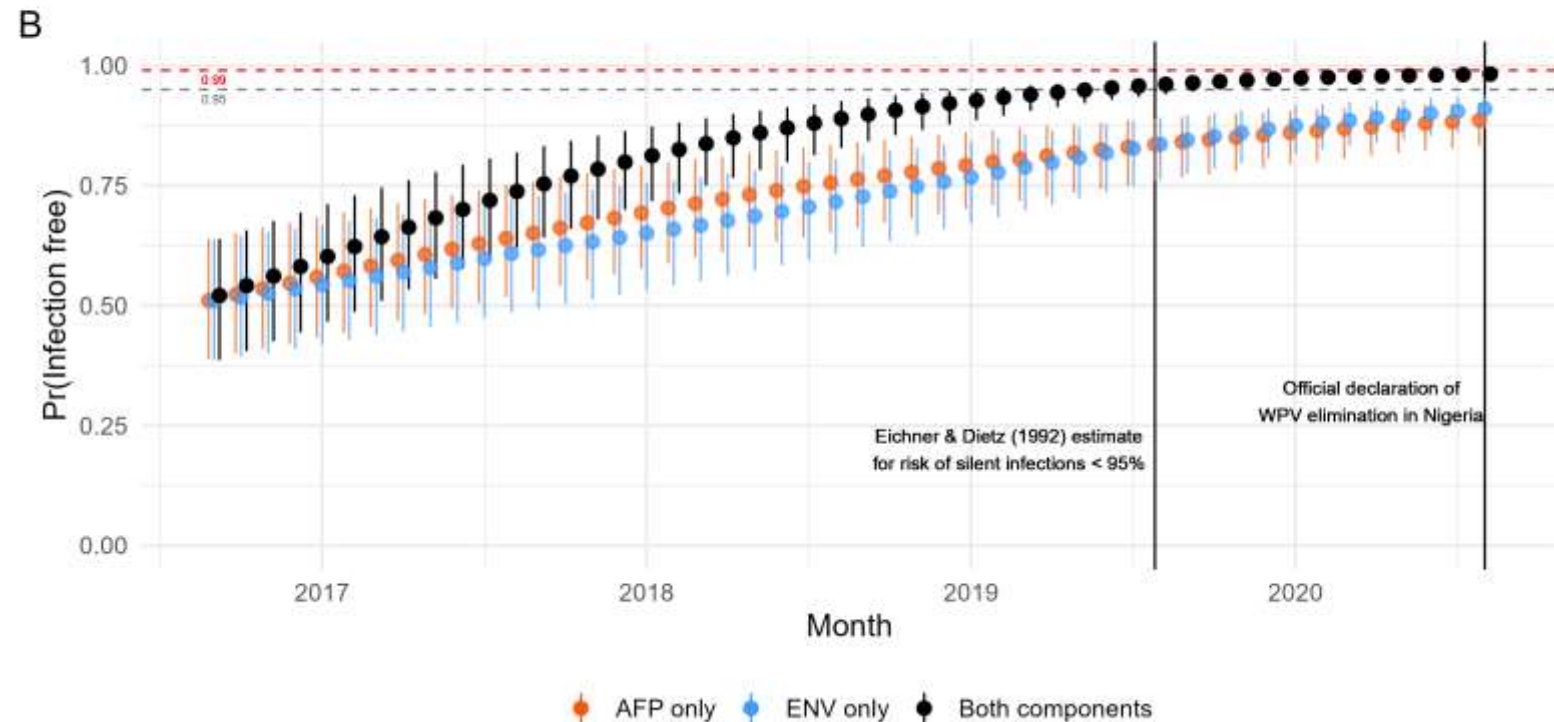
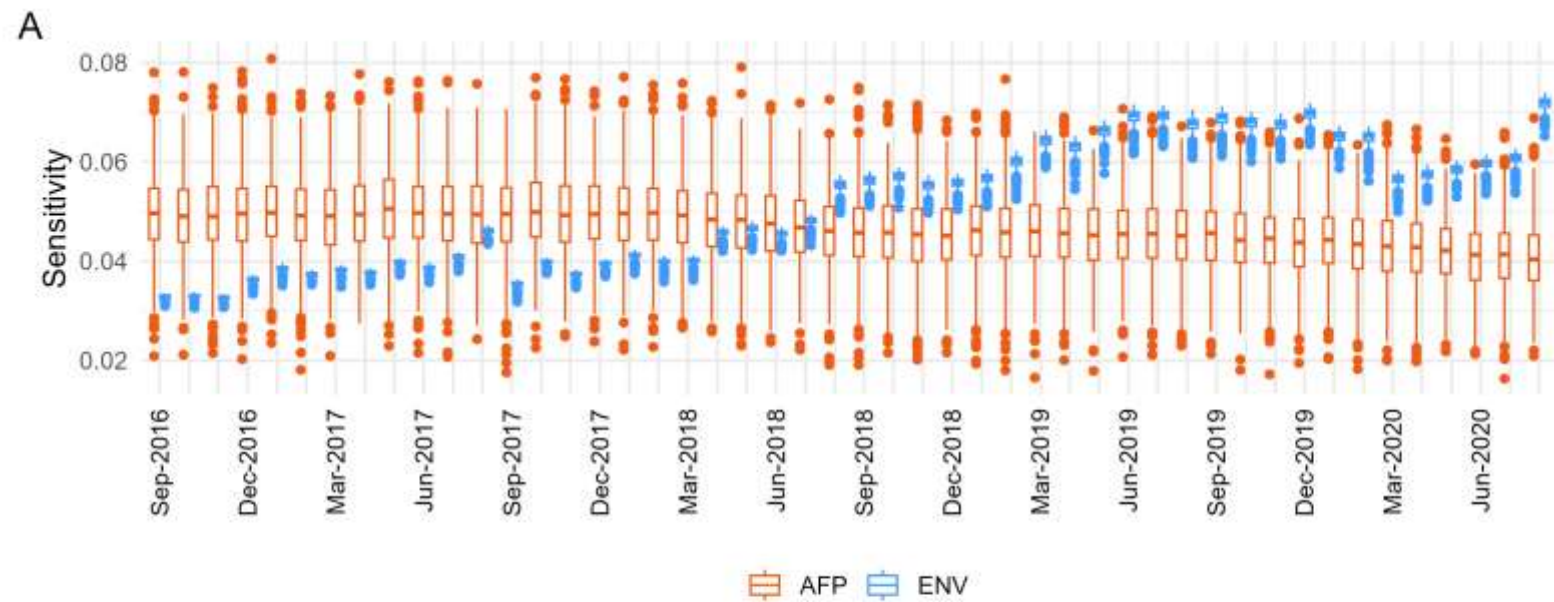


# 2016–2020

Since 2016, **ES expanded** while **AFP declined** (lower adequacy of stool collection)

Confidence in freedom from infection **consistent with official declaration**

- *> 95% after 34 months*
- *~99% by mid-2020 declaration*



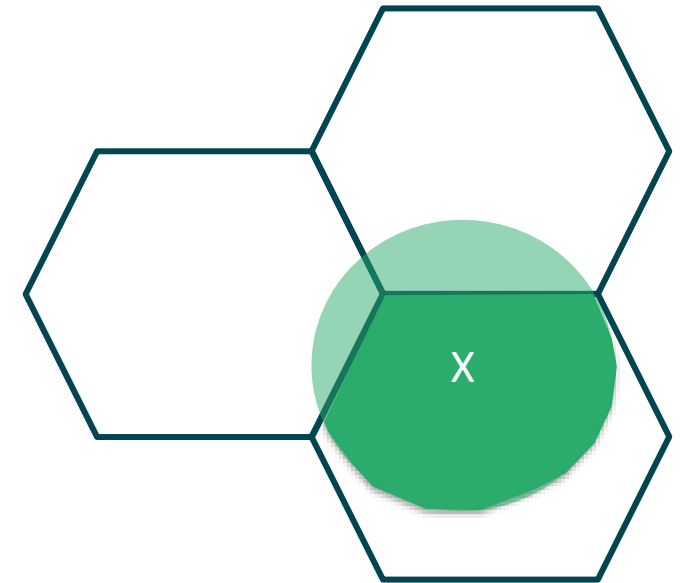
# Ongoing considerations

Undetected circulation in Borno was thought to be due to **conflict and resulting inaccessibility** in the region.

- *This disruption was not evident in routine surveillance indicators, so doesn't influence our estimates*

Population **catchment beyond LGA boundaries** is not incorporated

- *Extent will likely vary depending on weather conditions and characteristics of the site*



AFP and environmental surveillance are **complementary** approaches, and we aimed to quantify their **joint contribution** to evidence of elimination on a national scale.

With this framework, we integrate routine **indicators of performance** into the interpretation of **negative observations**.

- We draw conclusions that are **consistent** with both persistence during 2014-16 and elimination by 2020.
- Supports **prospective** use for inferring WPV elimination in **remaining endemic countries** (Afghanistan and Pakistan).

# Thank you!

## Co-authors:

Dr Kathleen O'Reilly

Dr Minh-Ly Pham

Dr Samuel Okiror

Dr Isah Mohammed Bello

Mr Tesfaye Bedada Erbetto

Prof Marycelin Baba

Prof Adekunle Adeneji

Dr Megan Auzenberg

Prof. W John Edmunds

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World Health  
Organization

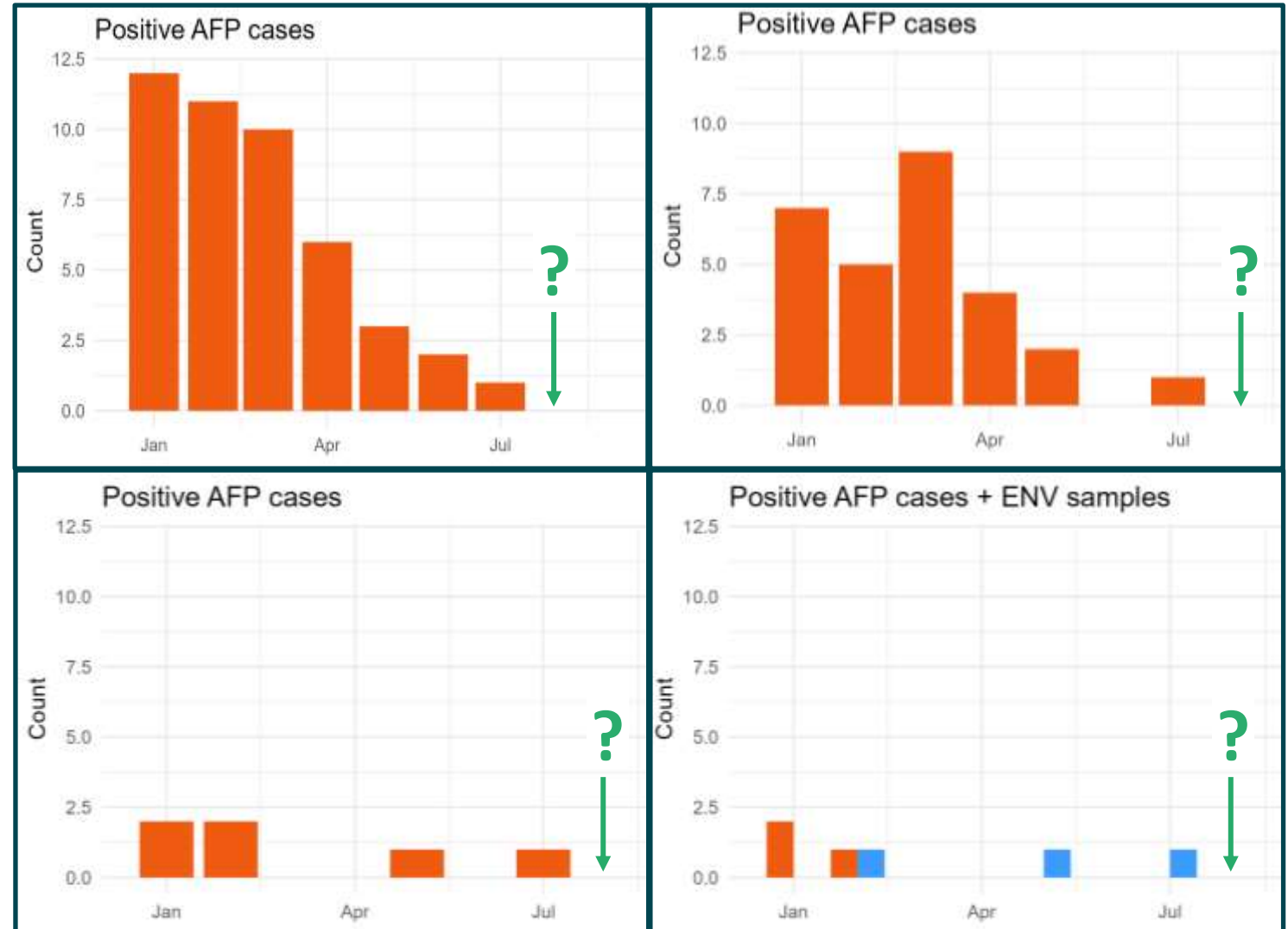
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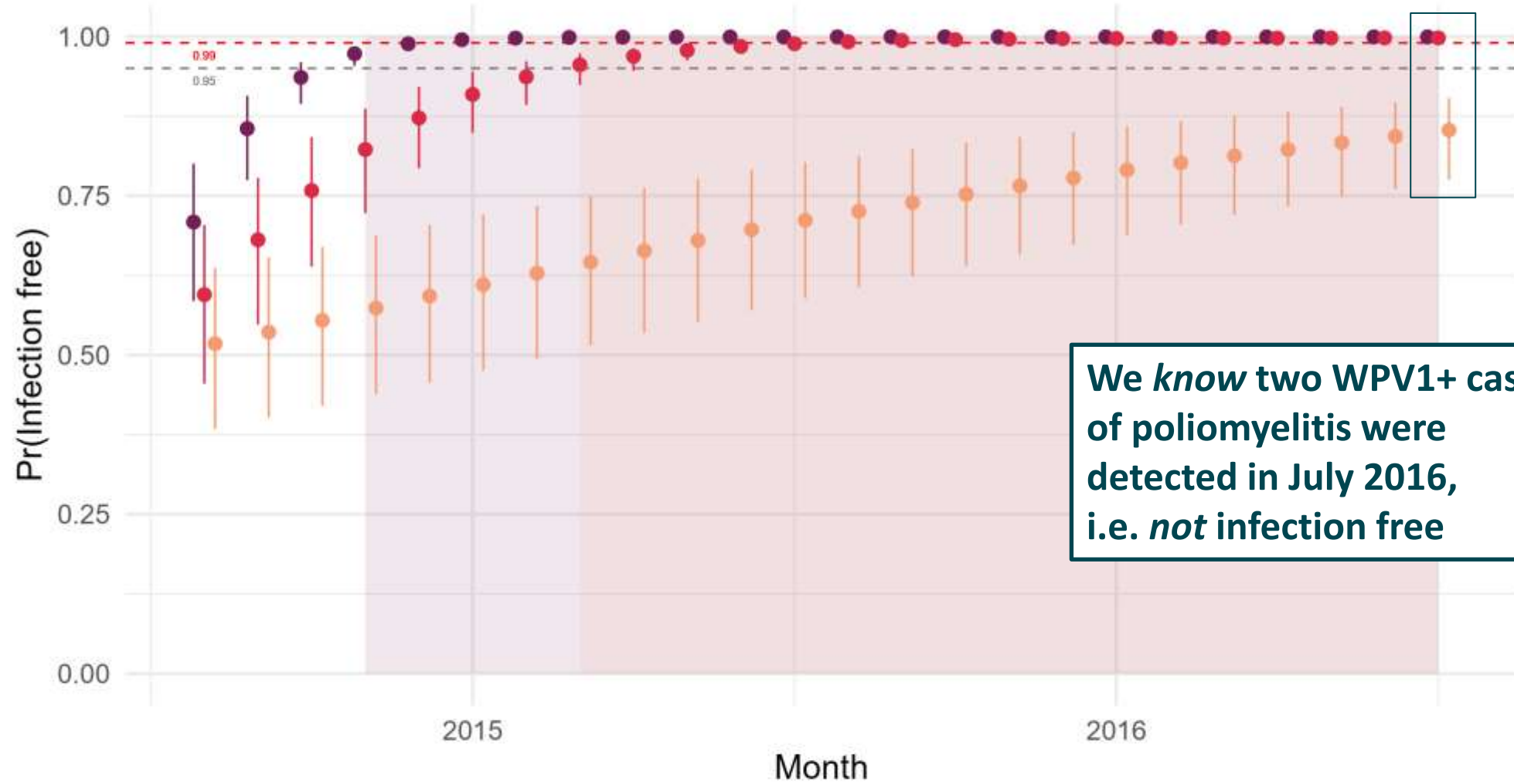
# Further considerations: Choice of prior

**We need a starting distribution (prior) for the first time point**

- How likely is it that the country is free from infection, given that a positive was observed *last month*?
- Judgment depends on the prior sequence of events



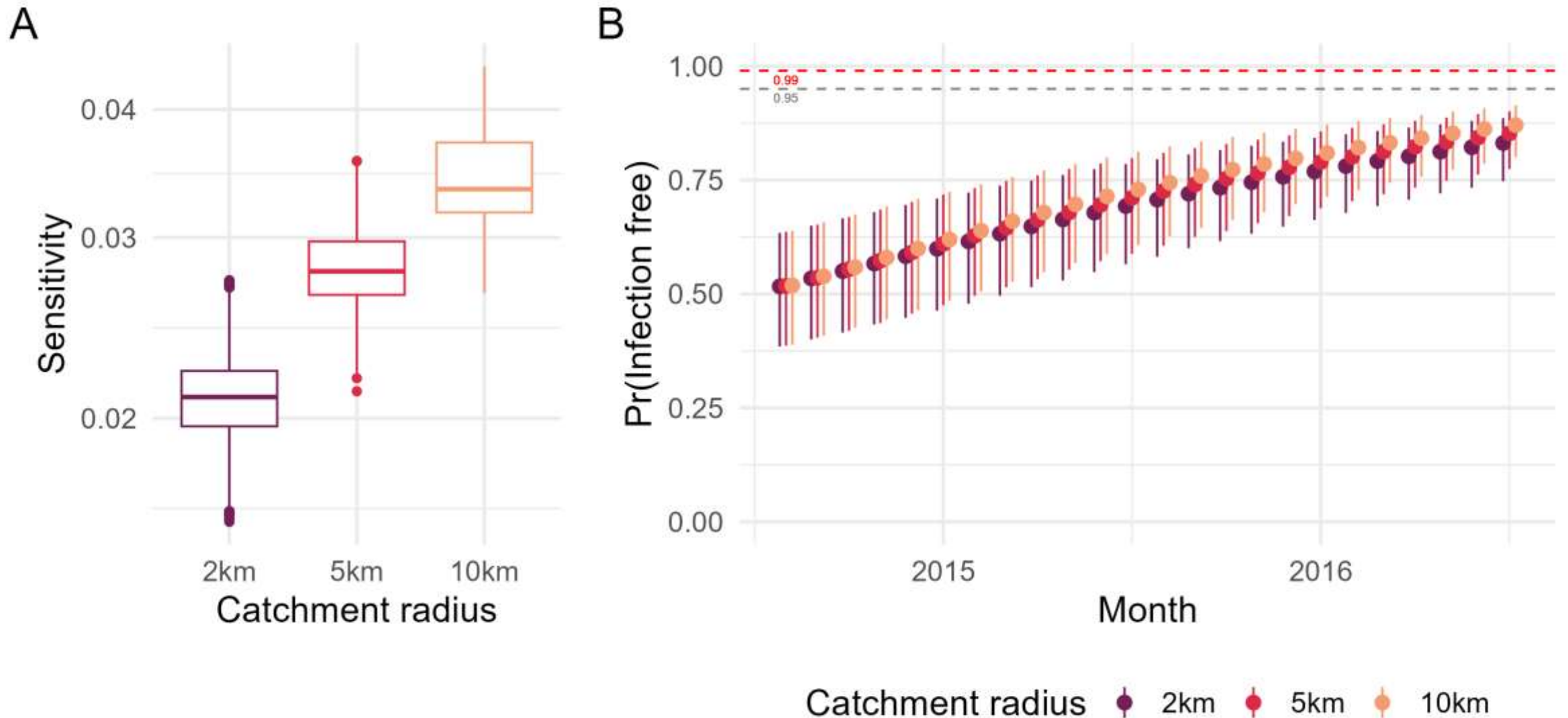
# Influence of design prevalence



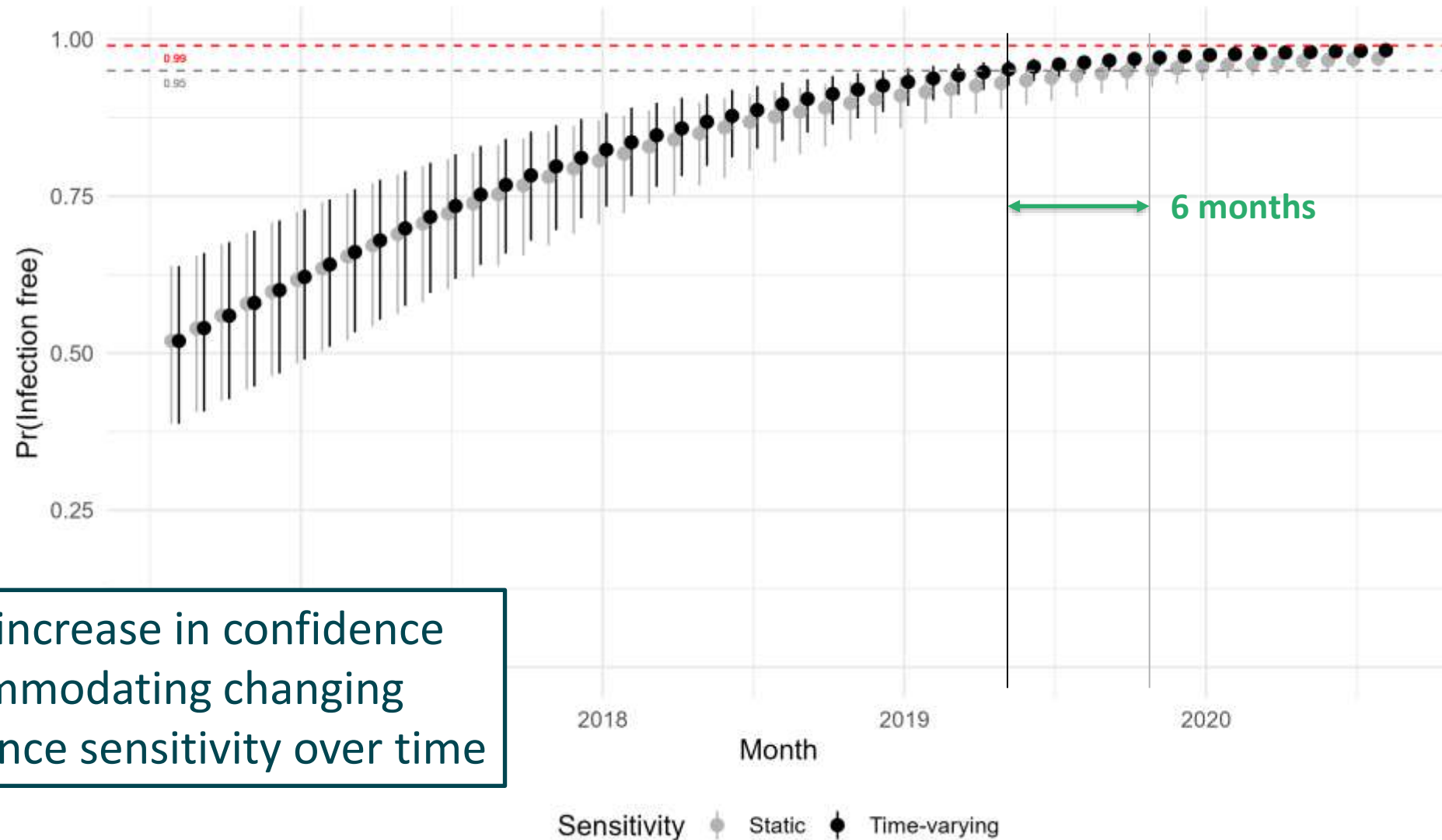
**We know two WPV1+ cases of poliomyelitis were detected in July 2016, i.e. *not* infection free**

Design prevalence 1/1,000 1/10,000 1/100,000

# Influence of catchment radius



# Static vs time-varying sensitivity



Quicker increase in confidence by accommodating changing surveillance sensitivity over time