BOVINE TUBERCULOSIS MOLOKA‘I- 2021

Hawai‘i Department of Agriculture

Animal Disease Control Branch/Animal Industry

2021 INCIDENT

- Keli‘iho‘omalu herd tested June 22, 2021
- Herd pastured in Mapulehu from December 2020 to June 2021
- Part of the herd returned to Ho‘olehua pasture in March 2021 under a Hold/Quarantine Order. Order in place due to March testing disruption caused by weather and cattle being out of feed and needing to move.

RECORD OF INSPECTION/QUARANTINE/PROVISIONAL QUARANTINE/SEIZURES

No. [redacted]

Consignee [redacted] Date 3/17/2021

Address [redacted] Phone [redacted]

Shipper/Address

Owner [redacted] Carrier Agent

No. of Crates No. of Animals 29 Type of Animals Beef Cattle

Health Certificate Issued By

Reason for Detention Due to weather causing dangerous travel, inability to complete herd TB testing

Warning Issued Your cattle herd may be moved to an isolated pasture in Hoolehua until retested negative for bovine tuberculosis.

Special Instructions/Remarks

You can proceed with processing your herd and moving them to Ho`olehua where they will remain under provisional quarantine/a hold order until retested for TB. Dur this quarantine period, you are required to comply with the following:

1) Cattle shall not be sold, removed, or added to your herd and your herd shall not mix or commingle with other cattle without the permission of the State Veterinarian.

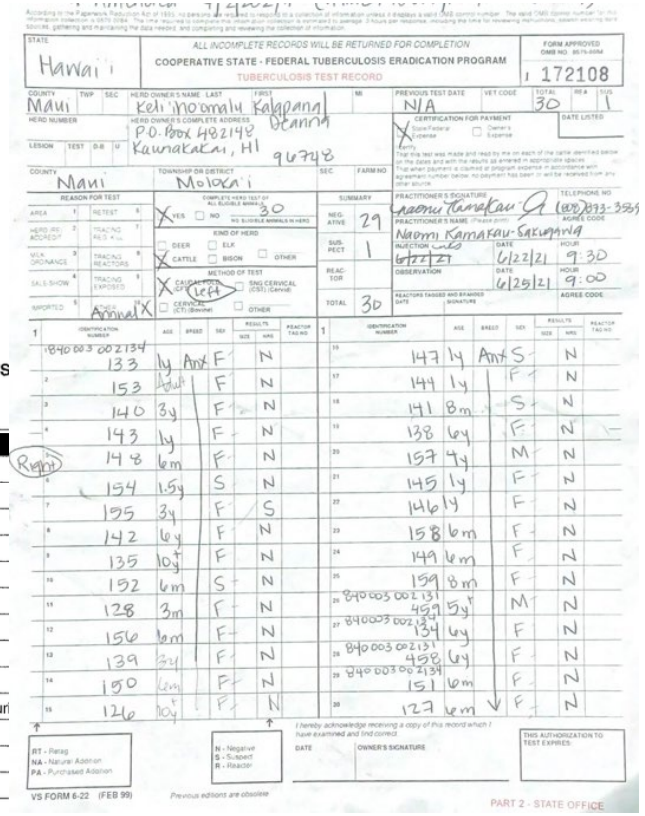
Description of Animals 29 Angus cross cattle, varying ages, varying sex

Disposition Hold herd in quarantine at approved Ho`olehua pasture

Quarantine Site Owner's pasture in Ho`olehua Retest Period 5/17/21 - 6/17/21

PROVISIONAL QUARANTINE REQUIREMENTS:

1. Shall be kept in quarantine (isolation) for a period of N/A days at the importer's/owner's premises or at a place approved by the State Veterinarian.
2. Shall report immediately to the State Veterinarian or representative all instances of sick and/or dead animals occurring during required isolation period. Oahu 483-7100; Kauai (808) 483-7100; Maui County 873-3559; Hilo, Hawaii (808) 974-6503
3. Any person who fails to comply with the provisions of Chapter 16 shall be fined not more than $10,000.00 or imprisoned not more than 5 years or both. (Class C felony)



STATE Hawai`i

ALL INCOMPLETE RECORDS WILL BE RETURNED FOR COMPLETION

COOPERATIVE STATE - FEDERAL TUBERCULOSIS ERADICATION PROGRAM

TUBERCULOSIS TEST RECORD

FORM APPROVED OMB NO. 0579-0395

172108

COUNTY Maui

HERD OWNER'S NAME LAST Keli`inoʻomalu FIRST Kalapana MI Deanna

HERD OWNER'S COMPLETE ADDRESS P.O. Box 482148 Kaunakakai, HI 96748

PREVIOUS TEST DATE N/A VET CODE TOTAL 30

CERTIFICATION FOR PAYMENT

COUNTY Maui TOWNSHIP OR DISTRICT Molokaʻi

REASON FOR TEST

COMPLETE HERD TEST OF ALL ELIGIBLE ANIMALS 30

KIND OF HERD

METHOD OF TEST Left

SUMMARY NEGATIVE 29 SUSPECT 1 REACTOR TOTAL 30

PRACTITIONER'S SIGNATURE Naomi Kamakau-Sakugawa

PRACTITIONER'S NAME (Please print) Naomi Kamakau-Sakugawa

INJECTION 6/22/21 OBSERVATION 6/25/21

	IDENTIFICATION NUMBER	AGE	BREED	SEX	RESULTS SIZE	RESULTS MM	REACTOR TAG NO.
1	840003002134	133	1y	Ant	F	N	
2		153	Adult		F	N	
3		140	3y		F	N	
4		143	1y		F	N	
5		148	6m		F	N	
6		154	1.5y		S	N	
7		155	3y		F	S	
8		142	6y		F	N	
9		135	10y		F	N	
10		152	6m		S	N	
11		128	3m		F	N	
12		156	6m		F	N	
13		139	3y		F	N	
14		150	6m		F	N	
15		126	10y		F	N	
16		147	1y	Ant	S	N	
17		144	1y		F	N	
18		141	8m		S	N	
19		138	6y		F	N	
20		157	4y		M	N	
21		145	1y		F	N	
22		146	1y		F	N	
23		158	6m		F	N	
24		149	6m		F	N	
25		159	8m		F	N	
26	840003002131	459	5y		M	N	
27	840003002134	134	6y		F	N	
28	840003002131	458	6y		F	N	
29	840003002134	151	6m		F	N	
30		127	6m		F	N	

RT - Retag NA - Natural Addition PA - Purchased Addition

N - Negative S - Suspect R - Reactor

I hereby acknowledge receiving a copy of this record which I have examined and find correct

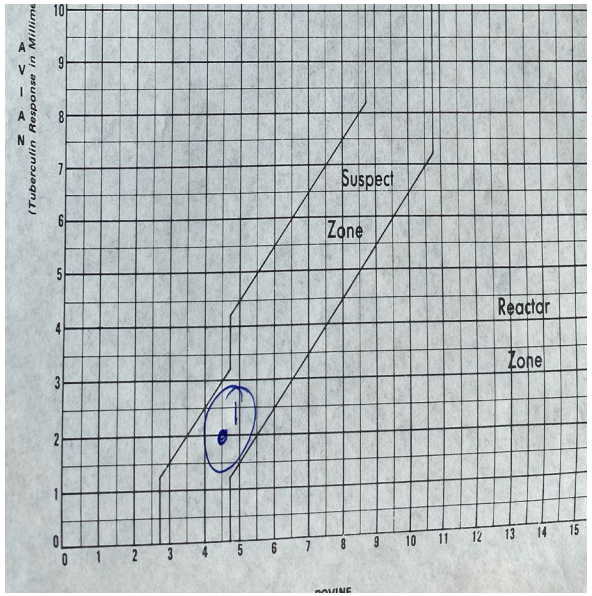
DATE OWNER'S SIGNATURE

THIS AUTHORIZATION TO TEST EXPIRES

VS FORM 6-22 (FEB 99) Previous editions are obsolete PART 2 - STATE OFFICE

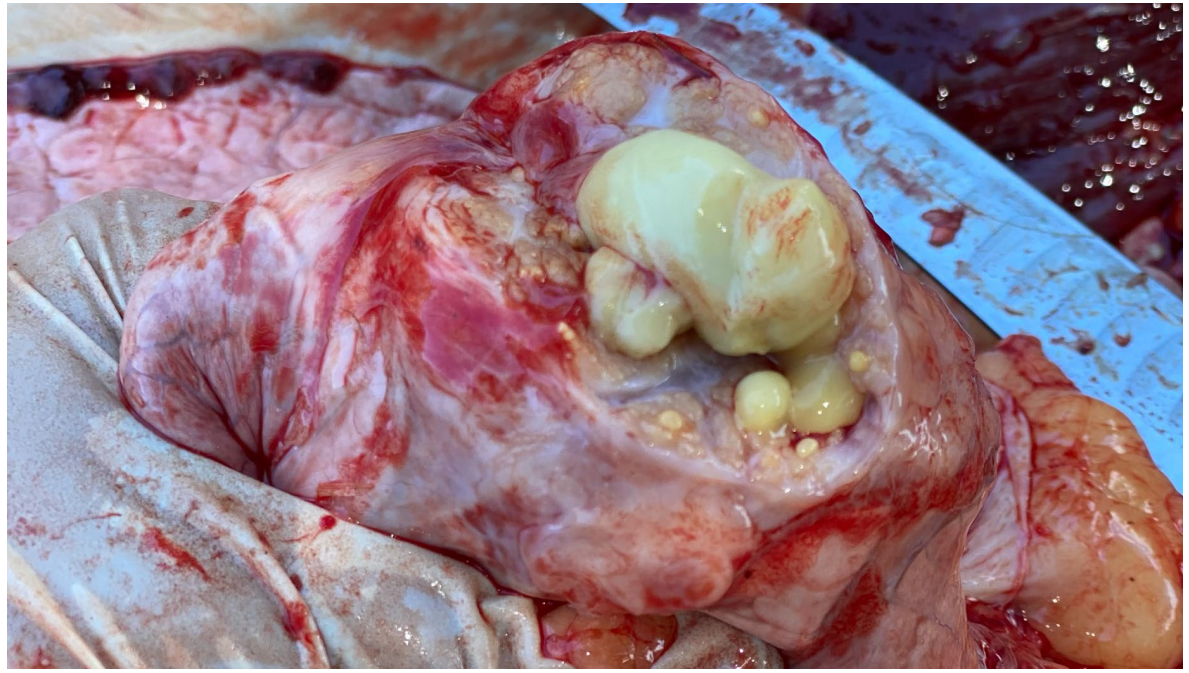
2021 INCIDENT – TB TEST

- Herd in Mapulehu
  - 3/16/21 – Initial caudal fold test (CFT) performed.
    - Due to the weather, unable to read the CFT scheduled for 3/19/21
  - Due to the drought conditions, under a hold/quarantine order, the herd was authorized to move back to their home pasture in Hoʻolehua



2021 INCIDENT – TB TEST

- Herd in Hoʻolehua
  - 6/22/21 – Thirty (30) head tested with one CFT suspect. Comparative cervical test (CCT) performed.
    - Hold order placed on herd
  - 6/25/21 – CCT test placed the cow in the suspect zone.
    - HDOA requested funds from USDA to purchase the cow as a suspect for euthanasia and further testing
    - Post-mortem examination was performed



NECROPSY FINDINGS

- ~ 3-inch diameter abscess was found in the lung and samples from the abscess and multiple lymph nodes were sent to the National Veterinary Services Laboratory (NVSL) in Ames, Iowa for further testing.

NVSL TESTING/FINDINGS

- Histopathology results: consistent with mycobacteriosis
  - Microscopic evaluation of lung tissue/abscess using special stains
- **Mycobacteriosis = disease caused by the bacteria *Mycobacterium* species.**
  - Various species of *Mycobacterium*
- **PCR test:** positive for ***Mycobacterium tuberculosis* complex**
  - ***M. tuberculosis* complex –** group of *Mycobacterium* bacteria (*M. tuberculosis, M. bovis, M. caprae* etc.)
  - ***M. bovis*** affects cattle – causes **bovine TB (bTB)**
  - *M. tuberculosis* – usual cause of tuberculosis in humans
- **Bacterial culture:** pending (8 weeks to complete)
- **Genomic Testing** (Is this a Molokaʻi bTB bacteria or from some other source?)

2021 INCIDENT – HISTOPATHOLOGY TEST RESULTS

Histopathology Analysis

Tissue Examined	Lymph node, thoracic
Tissue Examined	Lymph node, popliteal
Tissue Examined	Kidney
Tissue Examined	Lung

 Date Generated: 7/7/2021

Accession: **21-019240** Owner: [redacted] Referral/Tag Number:

Tissue Examined	Lymph node, head
Tissue Examined	Lymph node, abdominal
Diagnosis	Mycobacteriosis - compatible
Diagnosis	See below
Pathologist	Ann Predgen, DVM, MPS, MS

Morphological Diagnosis:

Kidney: Multiple renal cysts (incidental lesion)

Comments:

Caseous granulomatous pneumonia with mineralization, multinucleated giant cells and rare acid-fast rods. Within the caseous debris is a fragment of plant material surrounded by Splendore-Hoeppli material.

2021 INCIDENT – PCR TEST RESULTS

Animal ID: 840003002134155 **Case #** PS-21P4972 **Sample:** 6 FORMALIN JARS **Specimen Type:** Fixed Tissue **Species:** Cattle, Mixed breed **ID Type:** Official ID devices were received with tissue attached

PCR Analysis

A polymerase chain reaction (PCR) test was performed on formalin fixed tissue using primers for IS *6110* to identify *Mycobacterium tuberculosis* complex species, 16S rDNA to identify *Mycobacterium avium* species, and IS*900* to identify *Mycobacterium avium* subspecies *paratuberculosis*.

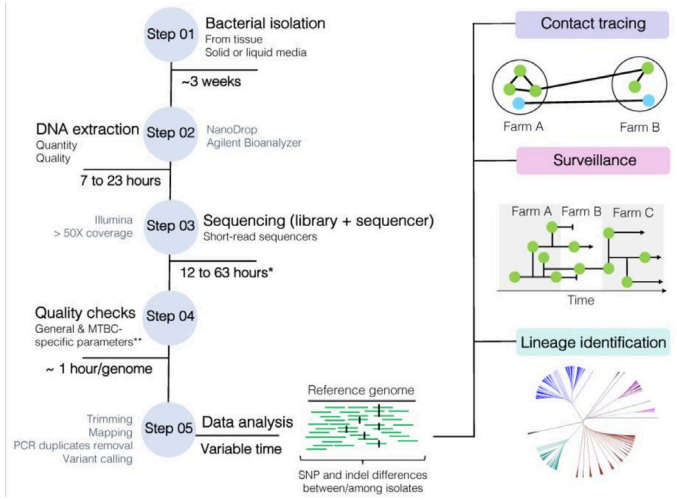
Results:
M. tuberculosis complex:
IS*6110*- positive
M. avium:
16S rDNA- negative
IS*900*- negative

Comments:

The sample was positive for *M. tuberculosis* complex IS*6110* DNA, presumably from *M. bovis*.

2021 INCIDENT – OTHER TESTS

- Mycobacterium culture – *pending*
  - Slow growing
  - Up to 8 weeks
- Genomic sequencing – *pending*
  - Determines if related to other bTB positive cases on Moloka‘i



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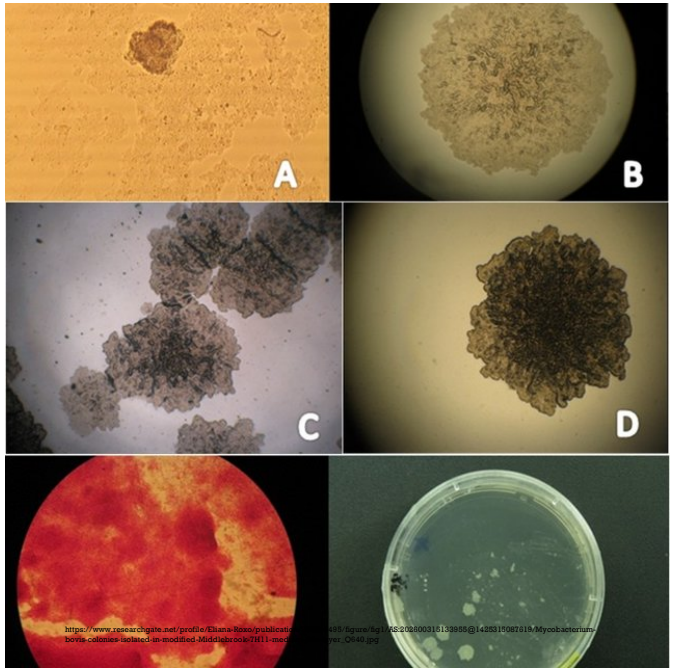


2021 INCIDENT - PLAN

- Depopulate herd
  - Molokaʻi slaughterhouse (4 weeks in August)
  - FSIS inspection
    - VMO to be present to inspect and send samples of pathology found
    - Meat from CFT negative animals that have no lesions will be slaughtered and deemed safe for human consumption
  - Clean and disinfect (C & D) premises
  - 30 days down time after C & D
  - Retest of reassembled herd 6 months and 12 months after reassembly and
- Contact herd tracing and testing

2021 INCIDENT – CONTACT HERD TESTING

Index herd = herd that has one or more infected animals

Contact herd = herd that had comingled, trespassed, or had fence-to-fence contact with the index herd

- Two contact herds have been identified
- Contact herds to be tested using the CFT

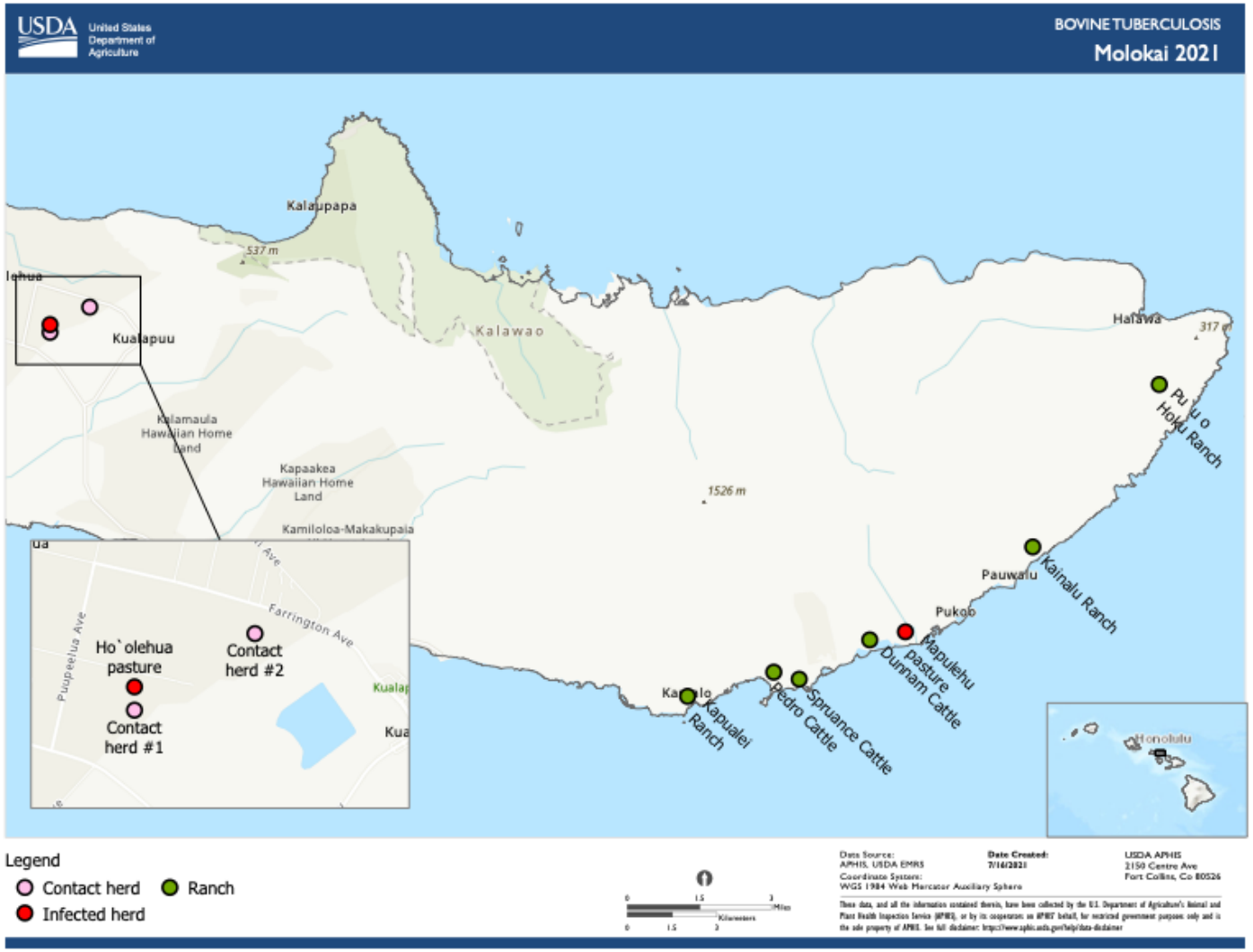
Trace-in herds = herds that sold cattle to the index herd and those cattle were found to be infected

- Currently, we have none

Trace-out herds = herds that received cattle from the index herd

- Currently, we have none

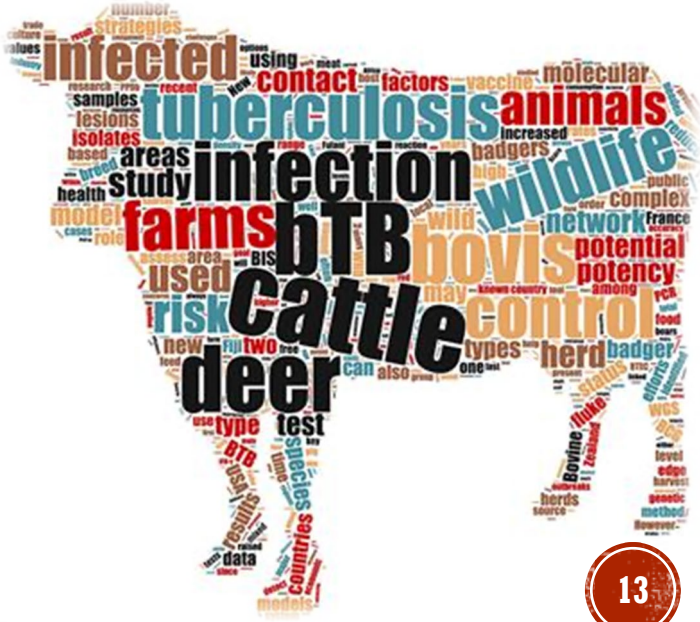
2021 INCIDENT - MAP



- Green dots – cattle herds located east of Kamalō that are TB tested annually

BOVINE TUBERCULOSIS

- Contagious, zoonotic disease caused by the bacteria *Mycobacterium bovis* (*M. bovis)*
  - *M. tuberculosis* - causative agent of tuberculosis in humans
- *M. bovis is a* member of "*M. tuberculosis complex*" group that cause tuberculosis in most mammalian species
- Primarily infects cattle, but transmitted between wildlife, other domestic livestock, and humans



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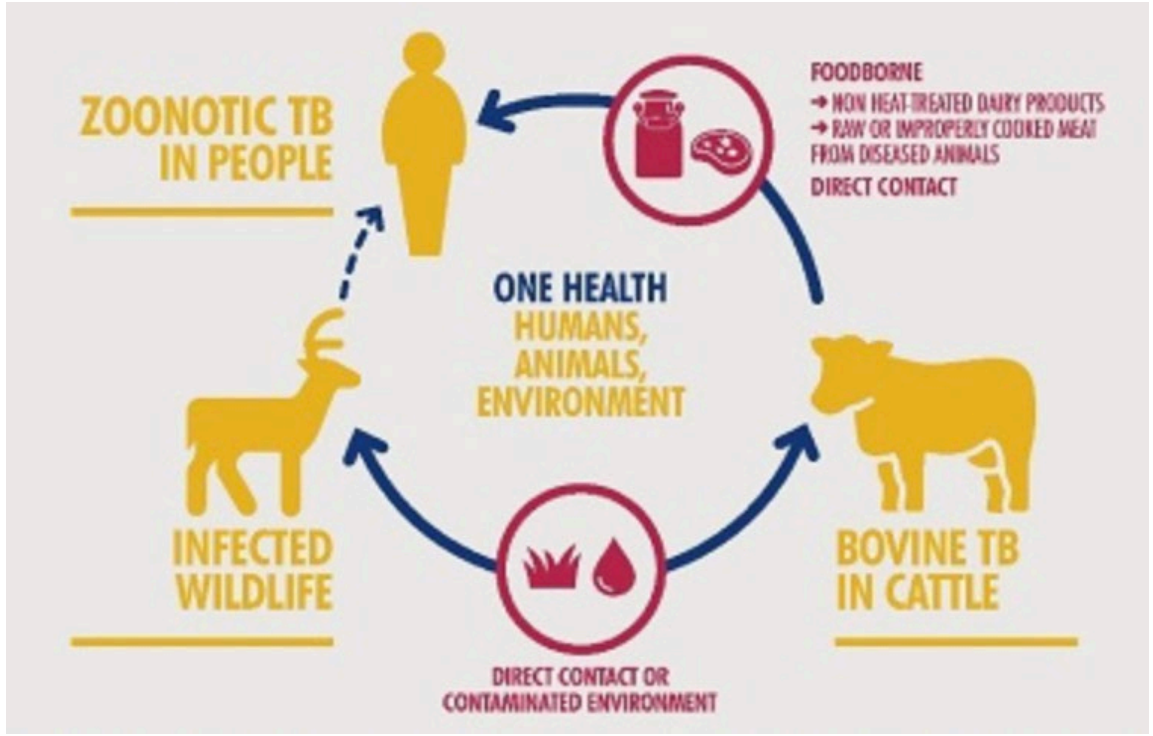
BOVINE & HUMAN TUBERCULOSIS



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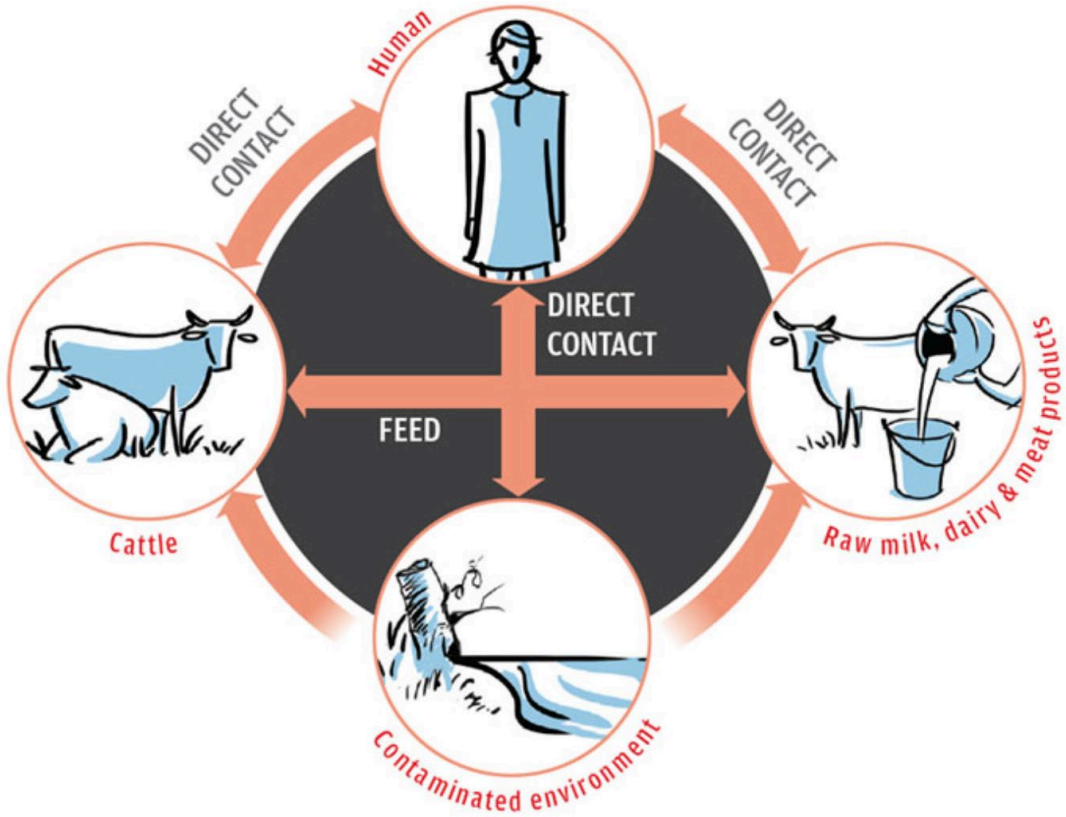
- In 2016, World Health Organization estimated over 140,000 people get sick with and more than 12,000 people die each year to **bovine tuberculosis (bTB)**[2]
  - Mostly in Africa and South-East Asia
- ~1.5-2 million people die each year from **tuberculosis (*M. tuberculosis*)** of the approximately **2 billion infected persons worldwide (approx. 25% of world population)**[1]
- **4 million new cases of tuberculosis in 2019**
- bTB was a major public health problem prior to pasteurization and eradication efforts
- Outbreak in dairy and beef herds continue to occur sporadically in the U.S. (Michigan, Wisconsin, South Dakota, New Mexico, Texas, Hawai‘i)

BOVINE TUBERCULOSIS

- Transmission
  - Exposure to infected blood, mucus, urine, milk saliva, feces or tissues
  - Examples:
    - Inhalation of aerosolized particles from infected animal
    - Ingestion of contaminated milk or food
    - Wounds
    - Contact with contaminated inanimate objects (fomites)



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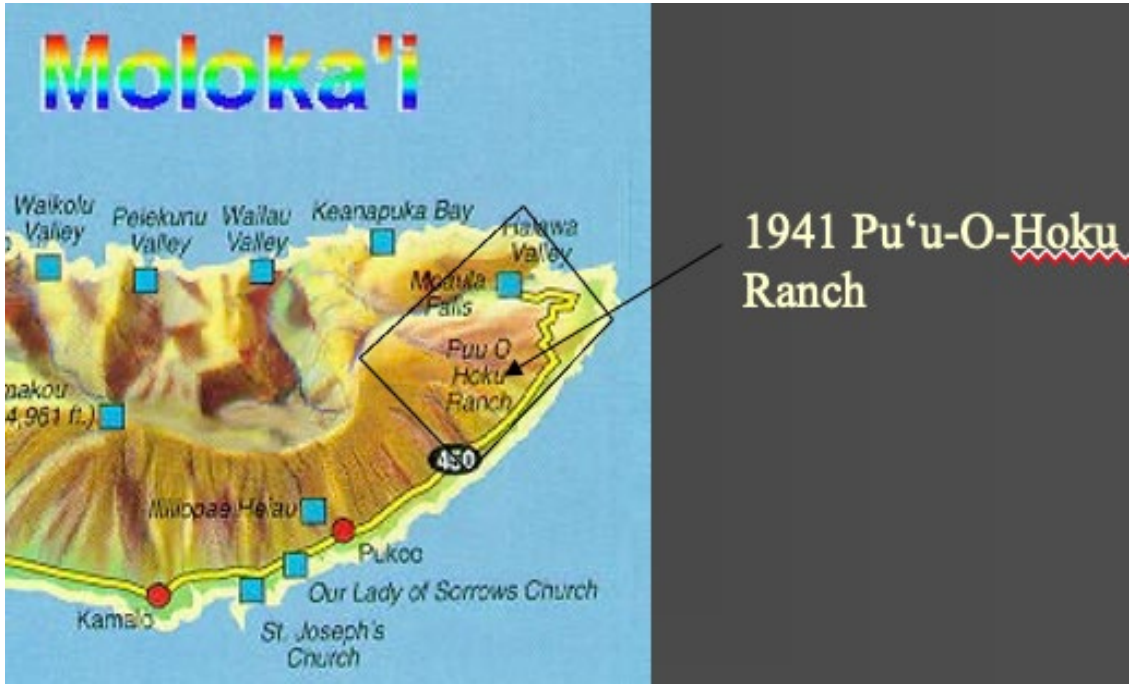
https://www.researchgate.net/profile/Selwyn-Headley/publication/280759738/figure/fig1/AS:297183409655814@1447865454942/Bovine

https://www.vetstream.com/Vetstream/media/images/Bovis/Bovine-tuberculosis-02.JPG?ext=.jpg

BOVINE TUBERCULOSIS

- Granulomas (tubercules)
  - Appearance – yellow, caseous, calcified
  - Abscess look-a-like
- Chronic and slow progressive onset
- Clinical signs vary widely
  - Enlarged lymph nodes
  - Breathing difficulties
  - Coughing
  - Weight loss etc.

HISTORY OF BOVINE TUBERCULOSIS ON MOLOKA‘I



First known infection of bTB on Moloka‘i (Pu‘u O Hoku Ranch)

Infection confirmed in feral cattle as they were being hunted/depopulated

1965 to 1985

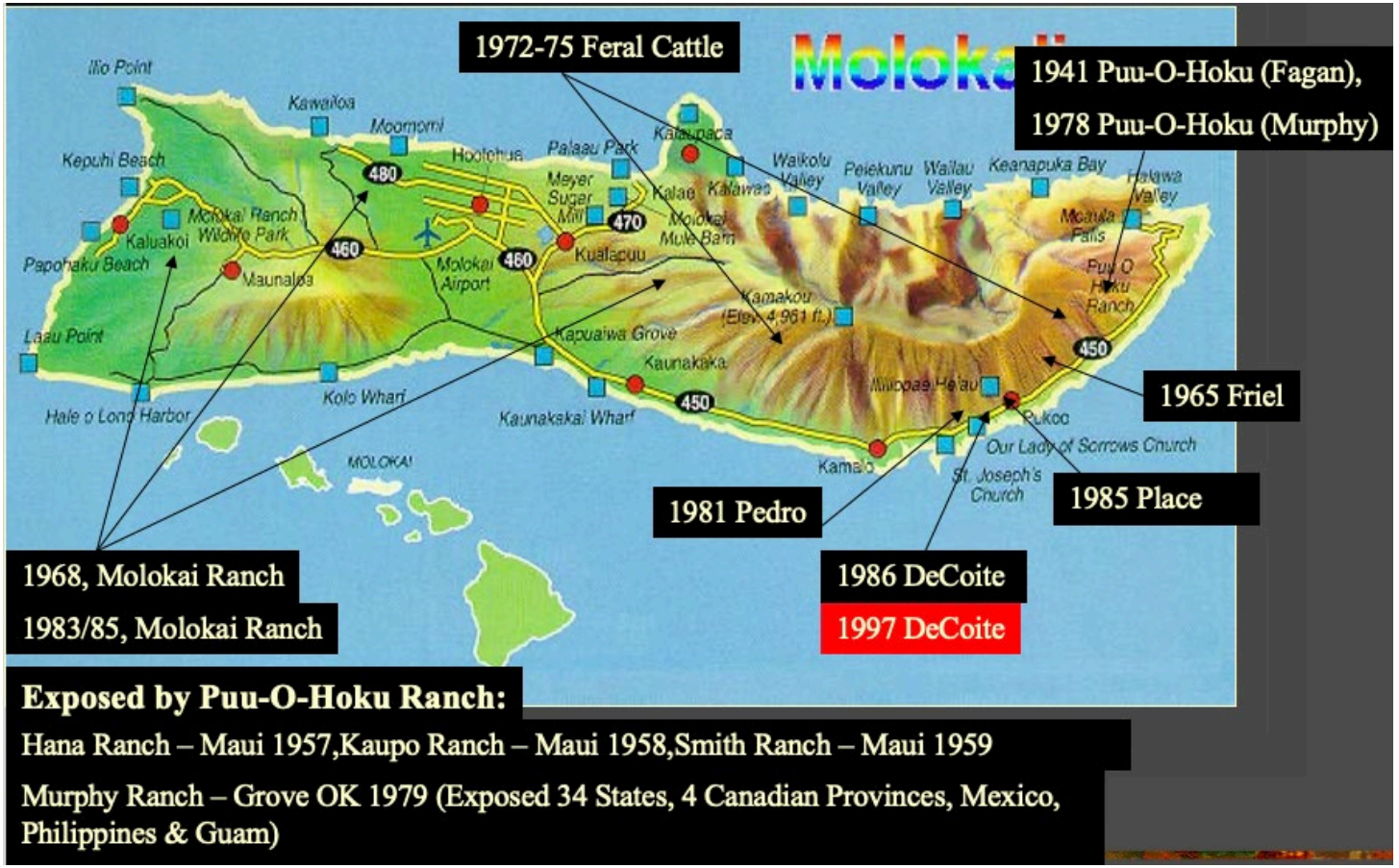
1941

1974 to 1976

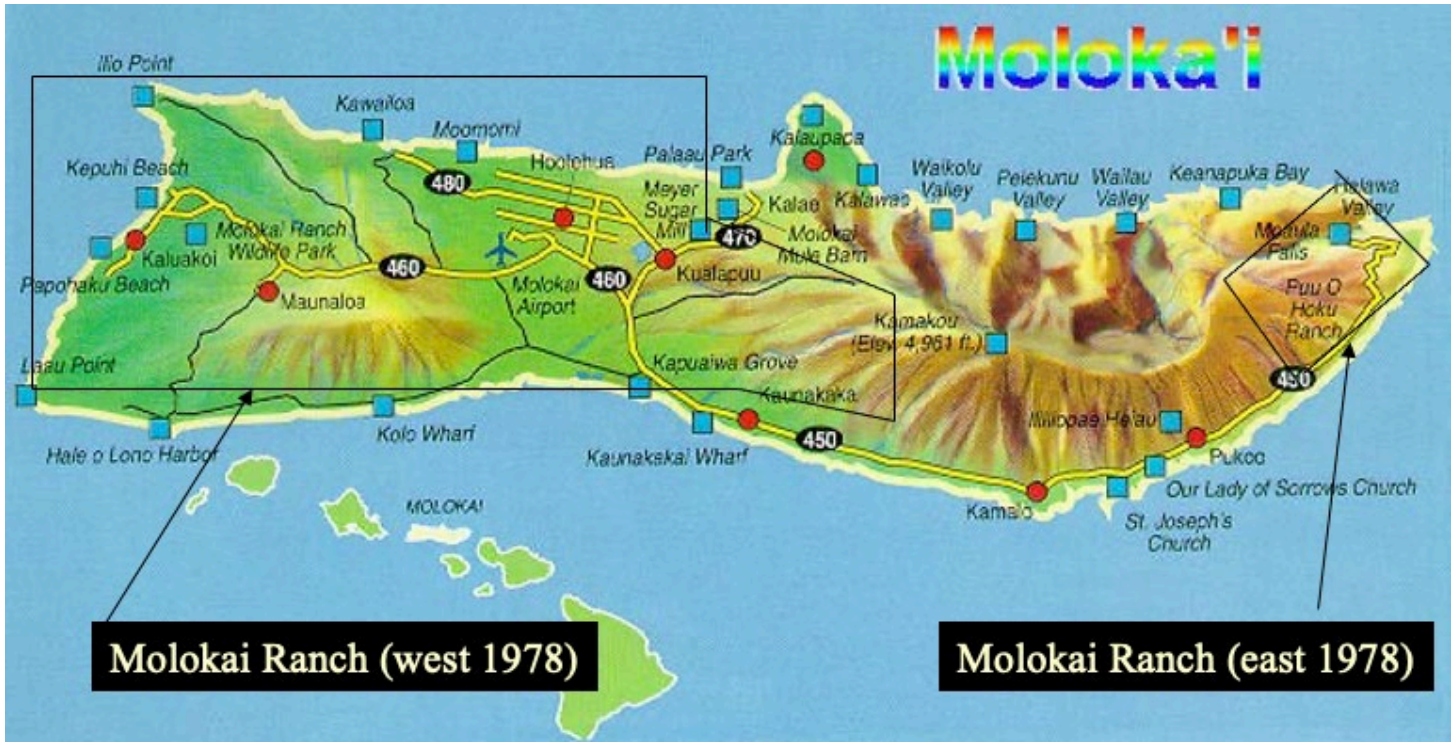
Multiple ranches, predominantly on East Moloka‘i, were infected --> tested --> depopulated --> reinfected

HISTORY OF BOVINE TUBERCULOSIS ON MOLOKA'I

- Affected and exposed cattle herds



HISTORY OF BOVINE TUBERCULOSIS ON MOLOKA'I



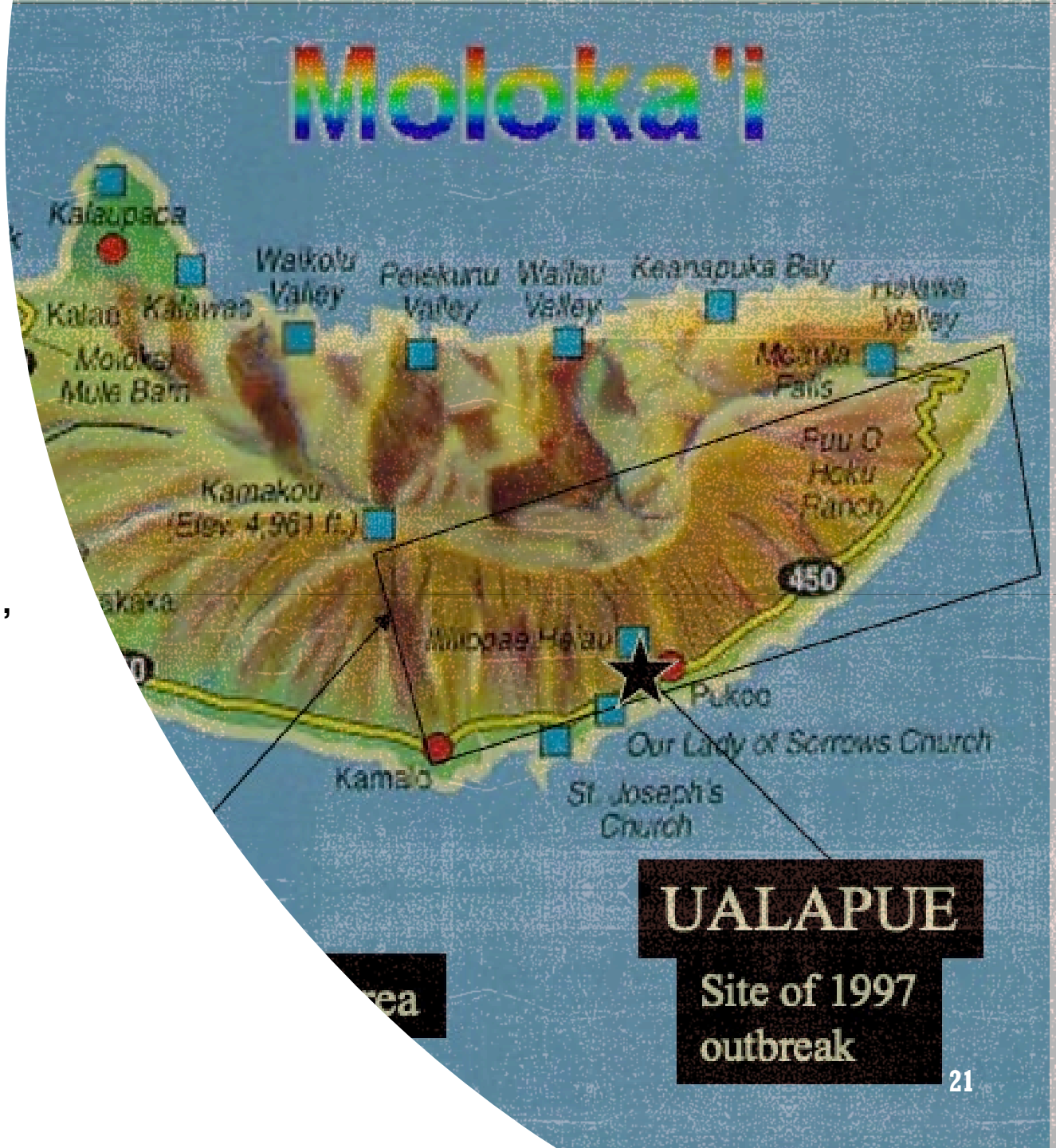
- 1978 – Pu'u O Hoku Ranch infected again
  - Pu'u O Hoku Ranch now owned by Moloka'i Ranch, run separately from Moloka'i Ranch's west end operation
- 1980 – Pu'u O Hoku Ranch depopulated
  - 60 head with lesions
  - Wildlife surveillance conducted after depopulation
    - Infected feral pigs found in the vicinity for the next 4 years
      - 1981 – 20%
      - 1983 – 1 pig
      - 1985 - 0

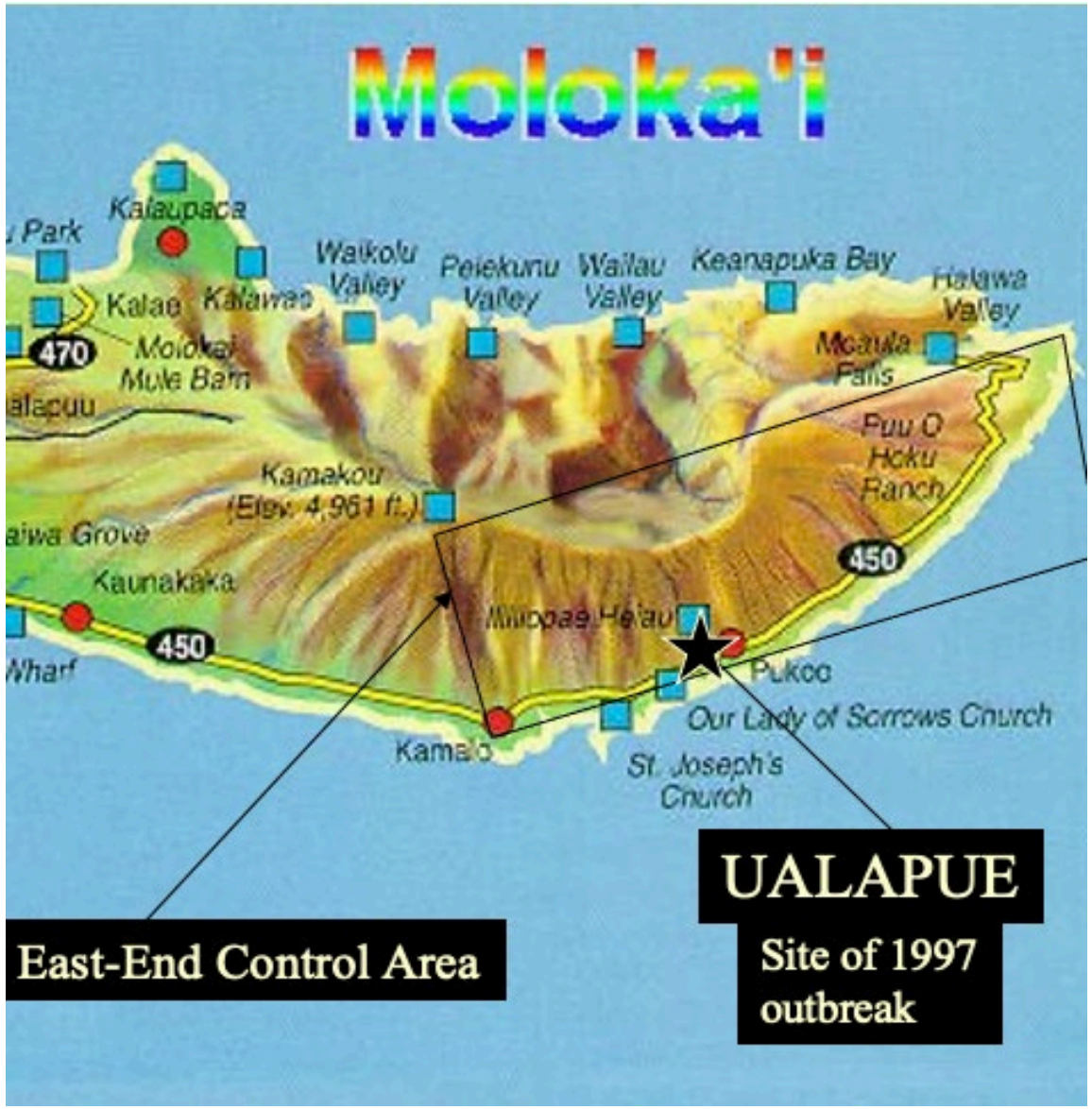
(1985) HISTORY OF BOVINE TUBERCULOSIS ON MOLOKA‘I

- **1985-1987 – Decision to depopulate all cattle on the island of Moloka‘i**
  - 9472 head depopulated
  - $3,387,986 in indemnity paid
  - Legal challenges
  - 9 head mycobacteriosis suggestive/compatible
  - One year completely vacant of cattle
  - Second year – steers only, slaughtered after one year
  - After two years, breeding cattle allowed to return (cattle tested before repopulation and again after one year on Moloka‘i)
  - At that time wildlife determined/considered not to be a reservoir for infection

(1997) HISTORY OF BOVINE TUBERCULOSIS ON MOLOKA‘I

- 1997 – Infected cow found at slaughter, originating from ‘Ualapu‘e
  - Herd tested and depopulated (450 head), no additional lesioned animals found
  - Investigation involved 25 herd tests on Moloka‘i and Maui
  - 4922 head tested
  - No additional infected animals found





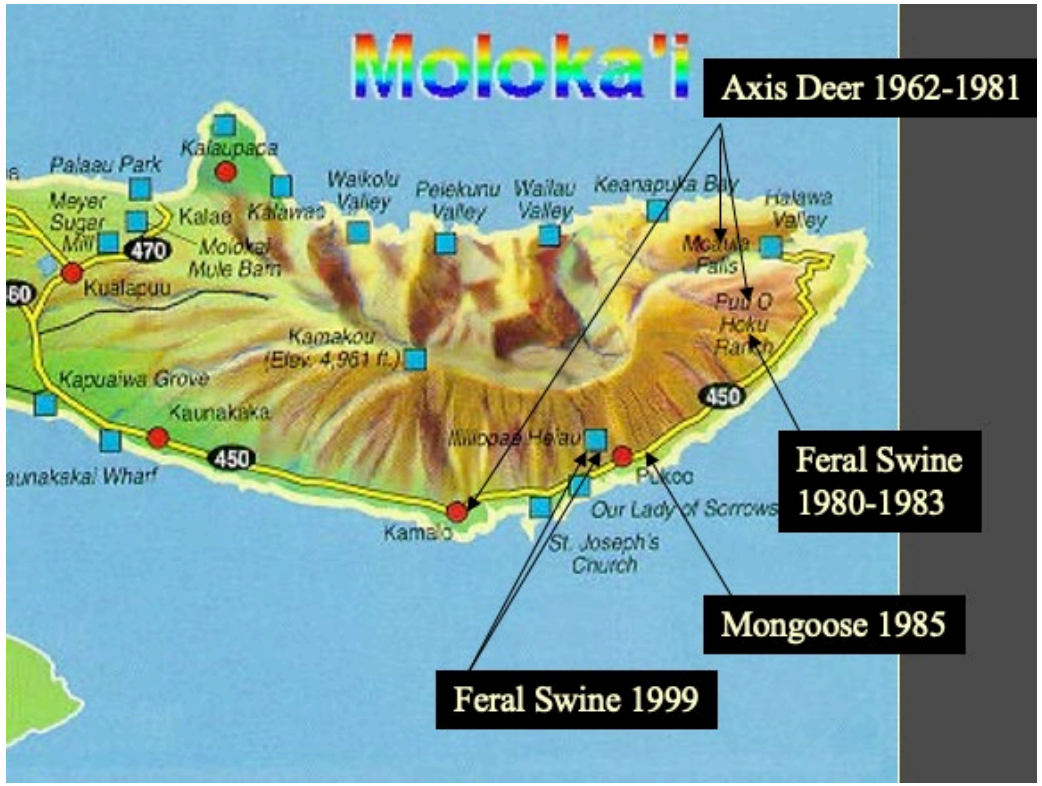
(1998 ON) MOLOKA'I BOVINE TUBERCULOSIS CONTROL PLAN

- Movement of cattle, goats, and captive axis deer from the east end of Moloka‘i restricted since 1997 (State permit required for all movements)
  - Must have negative CFT (caudal fold test)
  - OR, cattle/goats/deer for movement must be tested negative within 30 days prior to movement
  - Herds within a 2-mile radius of bTB infected wildlife are subject to complete herd tests
  - Home slaughters require post-mortem examination by State livestock inspector
- Hunter assisted wildlife surveillance survey – 1998 to 2020

WILDLIFE SURVEILLANCE STUDY – 1998 TO 2012, 2019-2020

- Local hunters paid $25-50 stipends to submit head and plucks from:
  - Axis deer
  - Feral swine
  - Feral goats
- State livestock inspector traps and submits tissues from mongoose
- Goal of 300 head of each specie followed by an assessment to determine risk for reinfection in cattle

WILDLIFE SURVEILLANCE STUDY – 1998 TO 2005



1962 to 1981

Axis Deer – five positive cases

1985

Mongoose – a pool of three animals sampled in 1985 from the same location an infected cow was found produced a single M. bovis colony

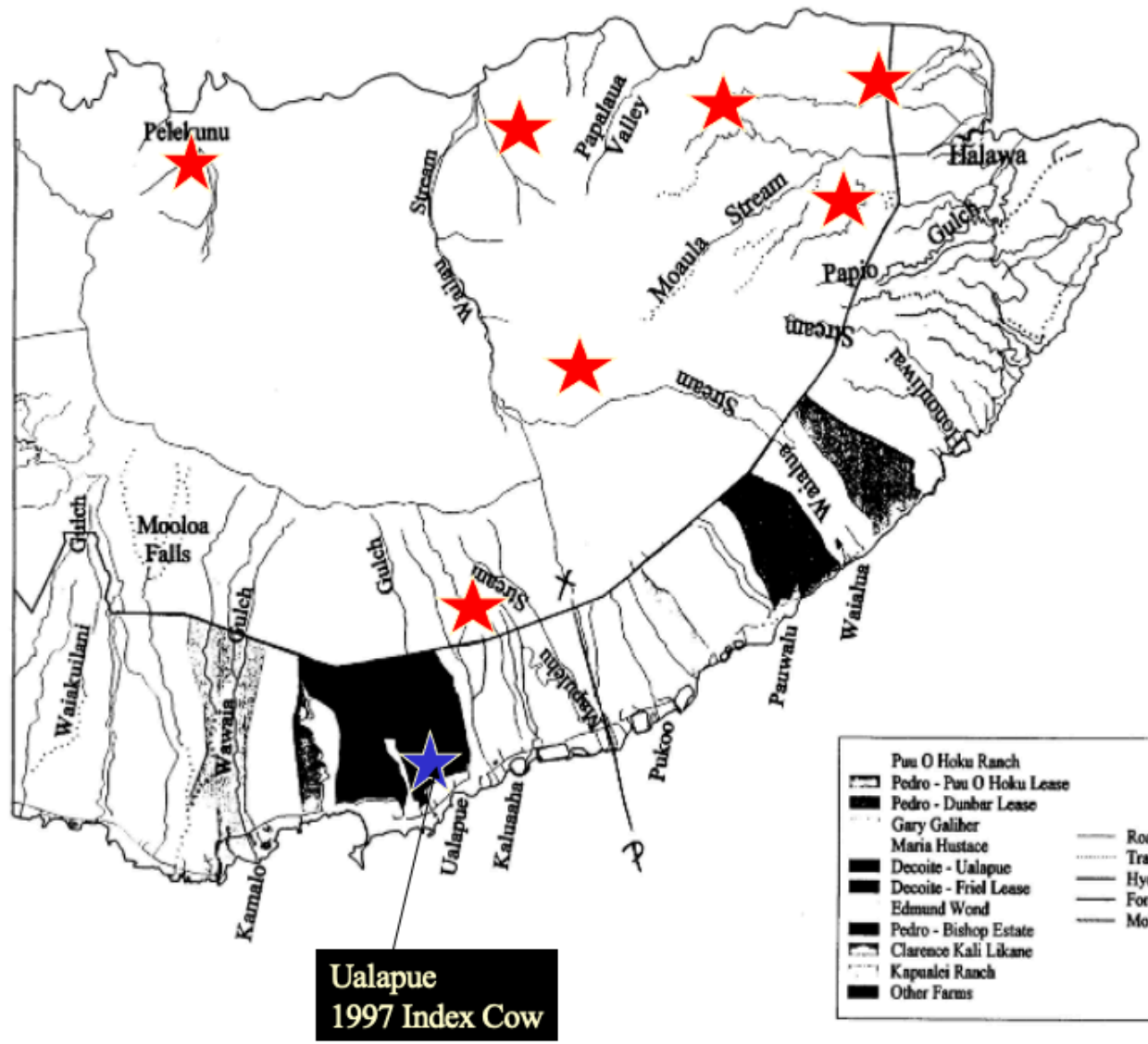
1981

Feral swine – 20% of feral swine tested at Pu‘u O Hoku Ranch were infected

- Subsequent to finding 60 lesioned head of cattle during the depopulation of the ranch

WILDLIFE SURVEILLANCE STUDY

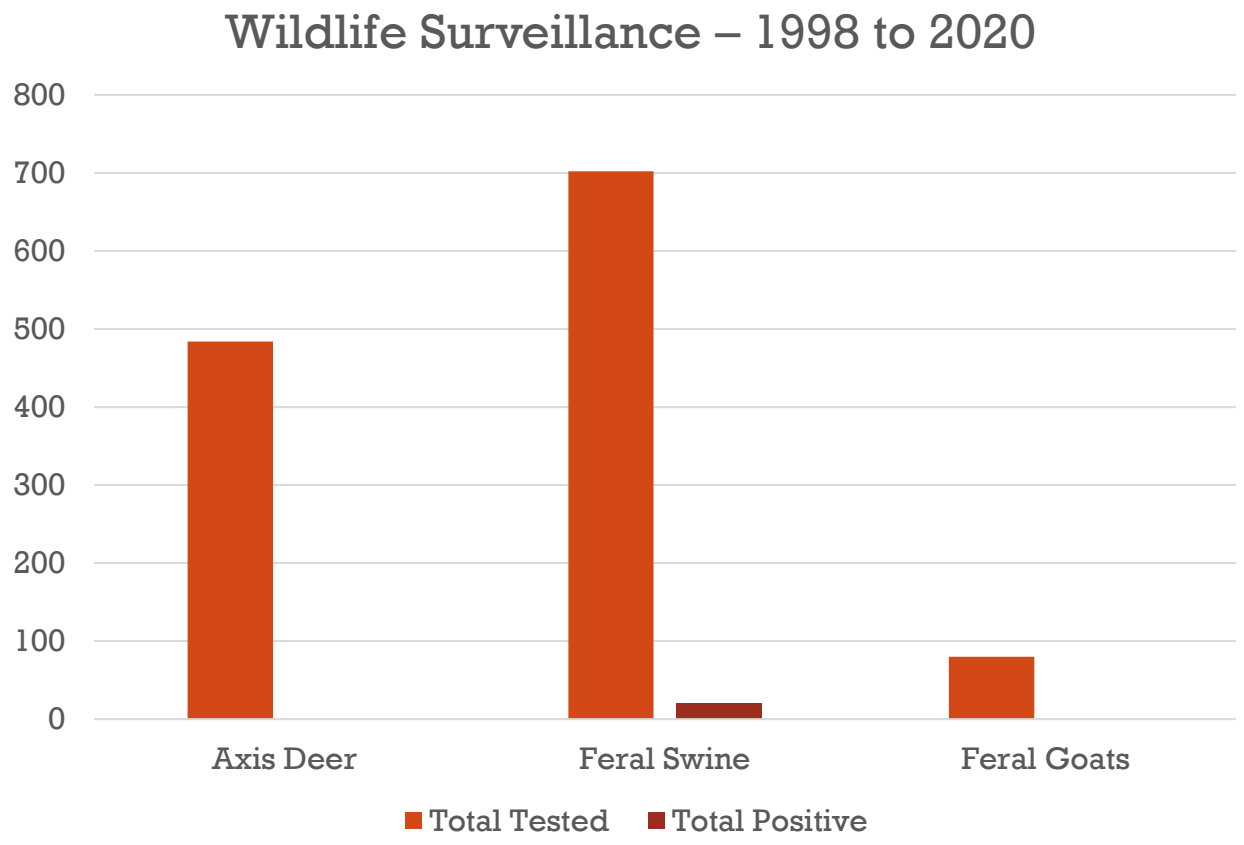
East Molokai



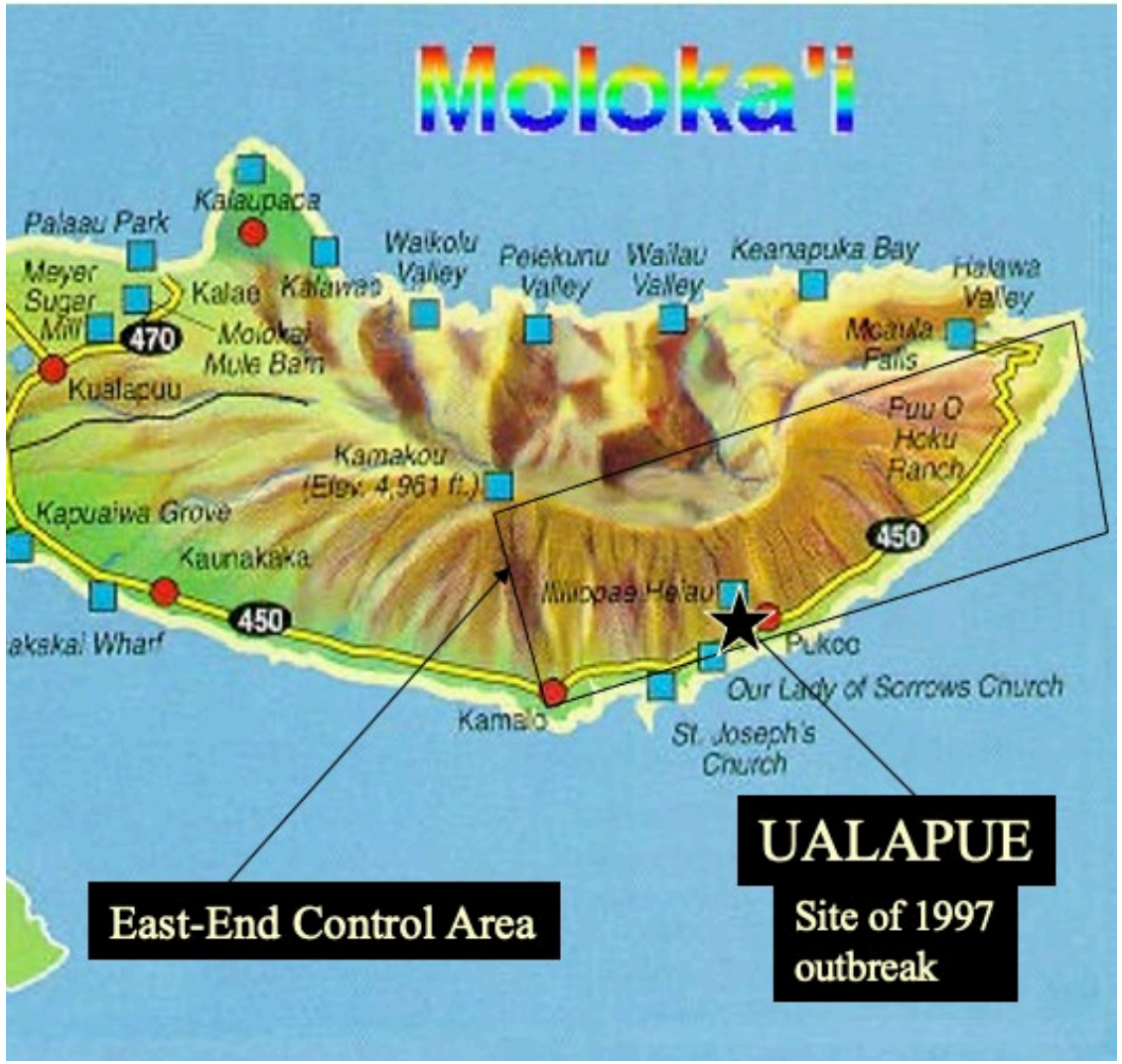
WILDLIFE SURVEILLANCE STUDY

WILDLIFE SURVEILLANCE STUDY – 1998 TO 2020 RESULTS

- Feral pigs:
  - 702 tested
  - 20 *M. bovis* positive (2.85% prevalence rate)
- Axis deer:
  - 484 tested
  - 0 positive
- Feral goats:
  - 80 tested
  - 0 positive



POSITIVE WILDLIFE CASES - MAP



CATTLE MOVEMENT RESTRICTIONS

- East end Molokaʻi herds allowed to move direct to slaughter or anywhere if they have a complete herd test in the past 12 months OR tested negative for TB within 30 days prior to movement
  - Since 1997
- Feral swine and axis deer not allowed to be transported west of Kamalō
- No additional impact on cattle movement intrastate or interstate as a result of this herd infection

BOVINE TUBERCULOSIS IN WILDLIFE

2019-2020 wildlife surveillance did not detect infected wildlife

- Objective: to determine if bTB still existed

Vaccine research – ongoing

- Several papers in Spain where bTB is highly prevalent among the European wild boar

Molokaʻi feral swine sent to Colorado and then to Iowa for research

- Comparing Molokaʻi feral pigs with those in the continental U.S. regarding bTB (immune response, diagnostics. Etc.)
- Initial objective: come up with an oral vaccine

How do we eradicate bTB in wildlife? Where do we go from here?

REFERENCES

1) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3087418/

2) https://www.who.int/news/item/12-10-2017-tb-partners-launch-first-roadmap-to-jointly-stop-the-transmission-of-bovine-and-zoonotic-tuberculosis