



Sources, detection, and environmental dissemination of *Cryptosporidium*

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Cryptosporidium Species and Hosts

Red = reported in human infections

Cryptosporidium andersoni

Cryptosporidium baileyi

Cryptosporidium bovis

Cryptosporidium canis

Cryptosporidium felis

Cryptosporidium galli

Cryptosporidium hominis

Cryptosporidium meleagridis

Cryptosporidium molnari

Cryptosporidium muris

Cryptosporidium nesorum

Cryptosporidium parvum

Cryptosporidium saurophilum

Cryptosporidium serpentis

Cryptosporidium suis

Cryptosporidium varanii

Cryptosporidium wrairi

Bovine

Chicken

Cattle

Dog

Cat

Birds

Human

Turkey

Fish

Mouse

Fish

Humans + 155 species of mammals

Lizards

Snakes

Pigs

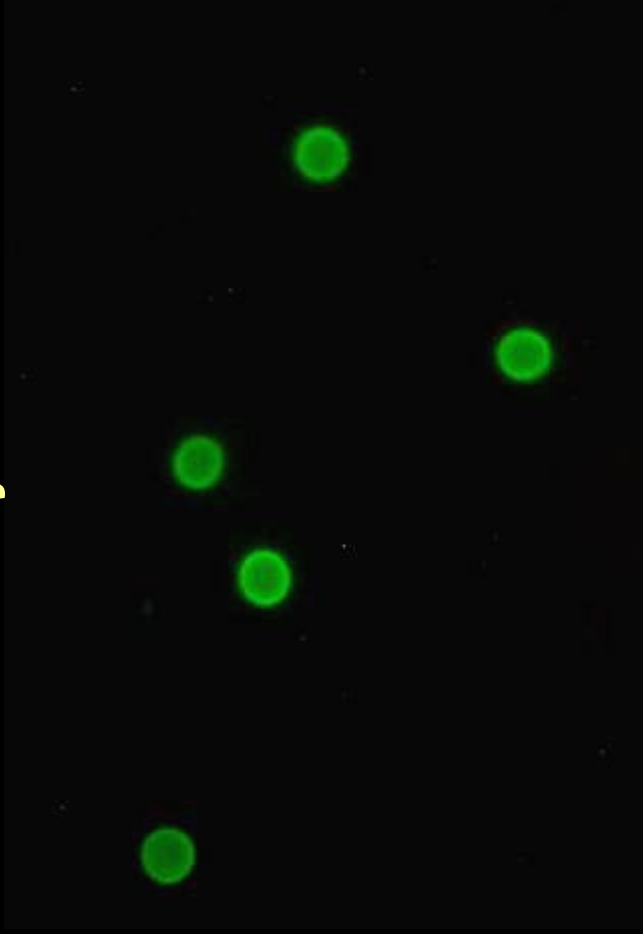
Emerald monitor lizard

Guinea pig

Environmental and Intestinal Stages

C. parvum, bovine source (Mer/Fluor™ stain)

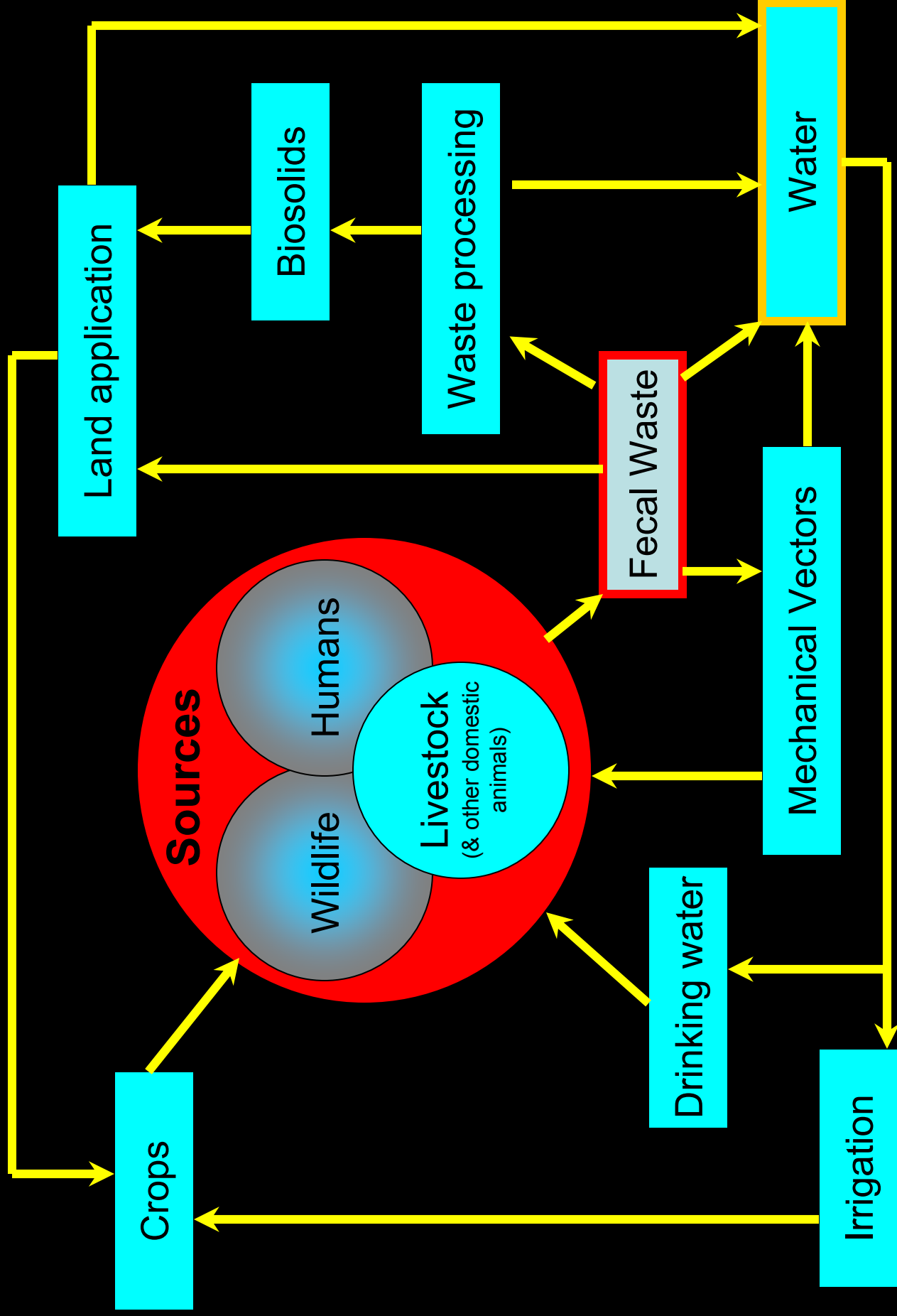
Oocysts



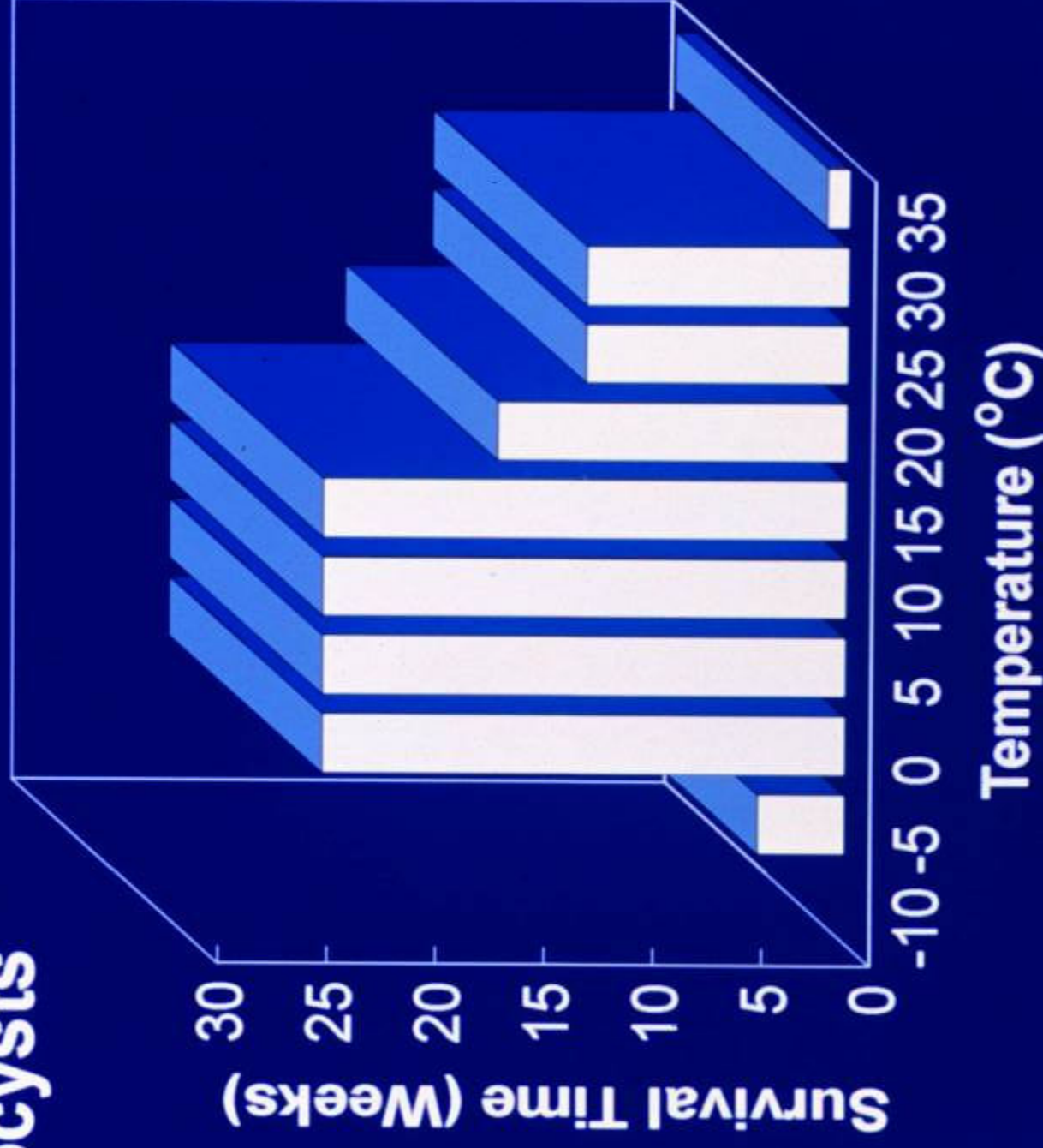
Meronts



Potential Environmental Transmission Pathways



Effect of Time vs Temperature on Infectivity of Cp Oocysts



SURVIVAL AND INFECTIVITY OF OOCYSTS: 12 WEEKS INCUBATION IN SEAWATER

PPT

10C

20C

0

10

20

30

I

I

I

I

I

NI

I

NI

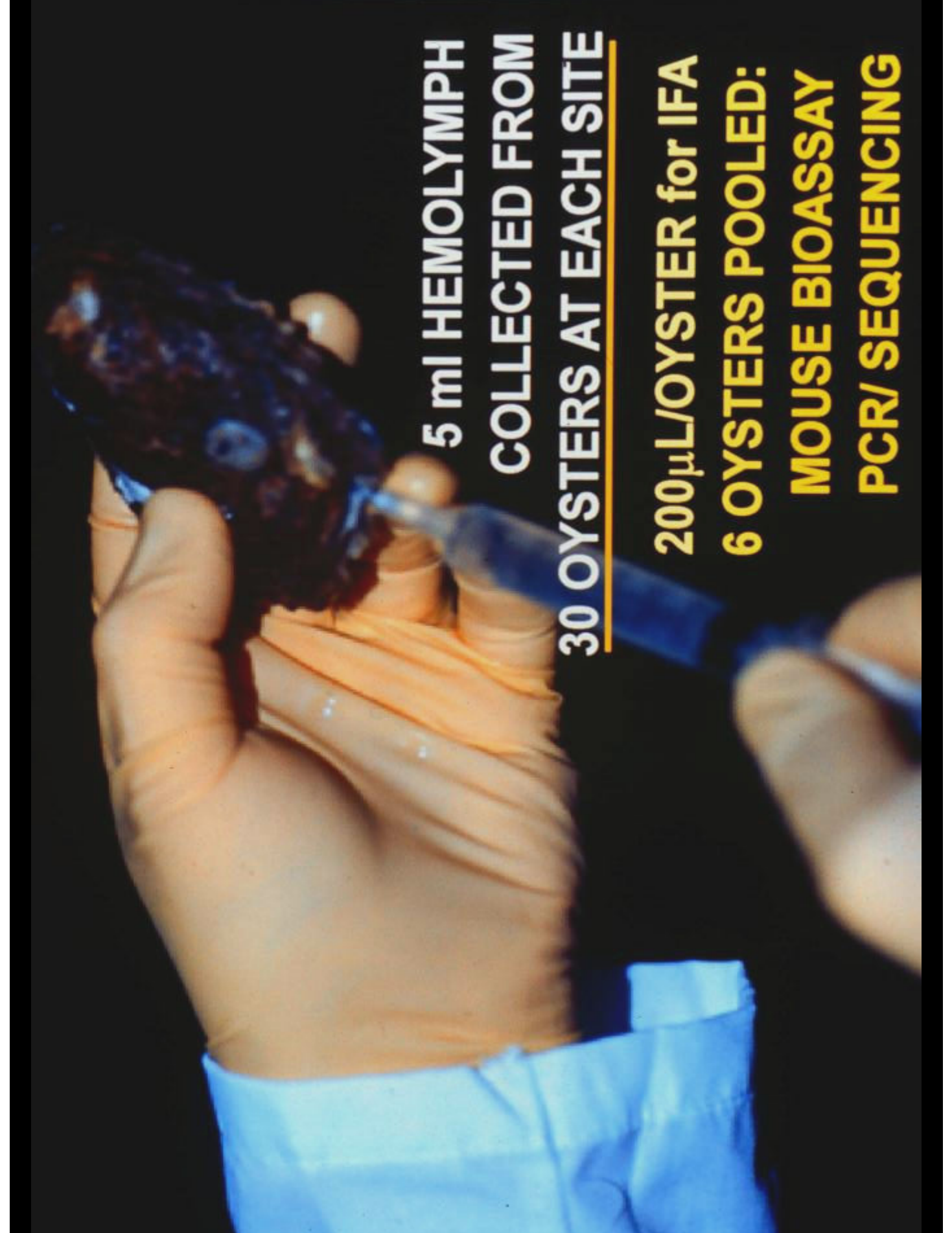
I = Infectious

NI = Not infectious



Oysters Studies

- **Filter feeders**
 - filter very large volumes of water
 - select particles of similar size to oocysts
 - may be good bio-indicators of contamination
- **Often eaten raw**
 - role in human infection

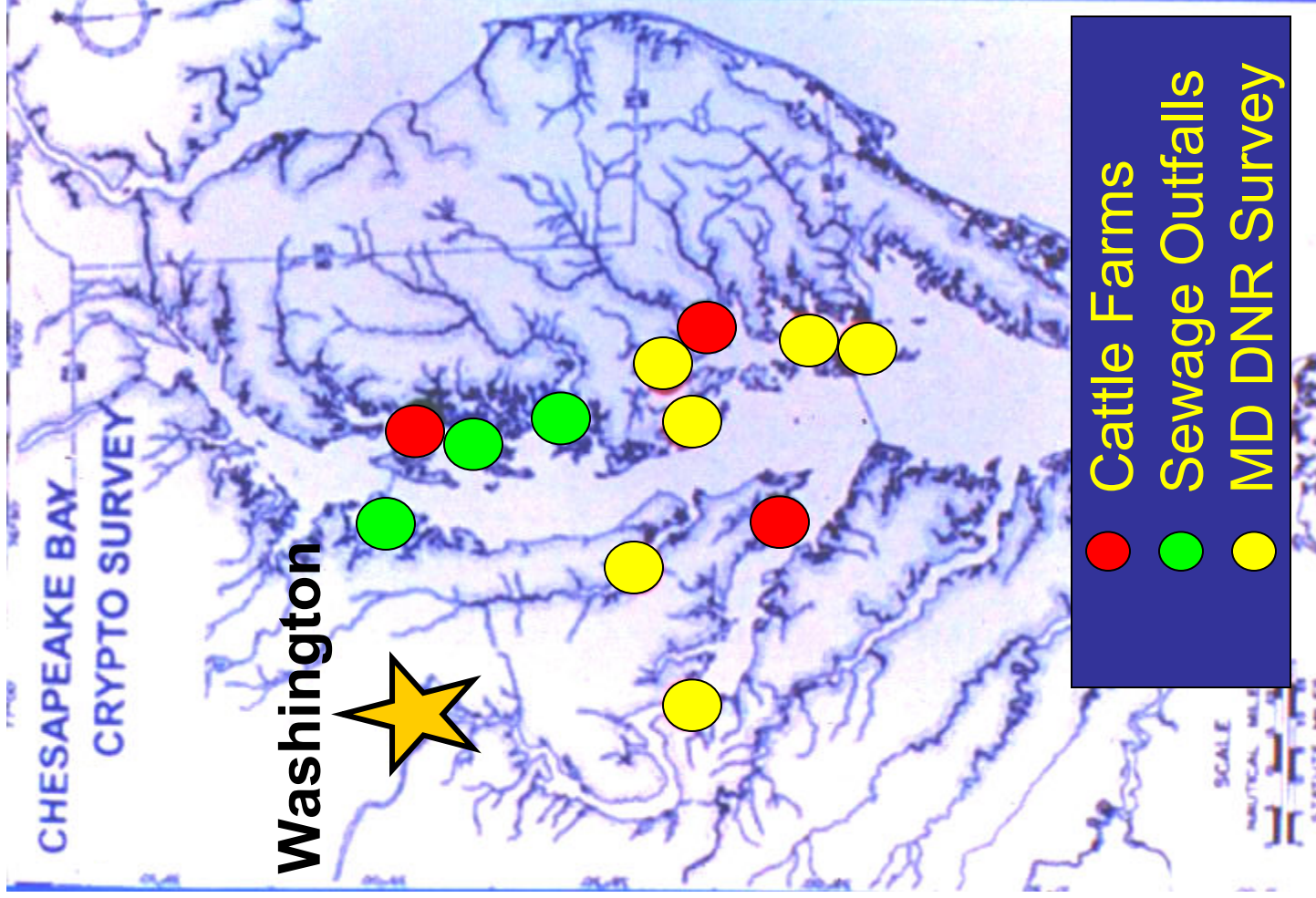


**5 ml HEMOLYMPH
COLLECTED FROM
30 OYSTERS AT EACH SITE**

**200 μ L/OYSTER for IFA
6 OYSTERS POOLED:
MOUSE BIOASSAY
PCR/ SEQUENCING**

GILLS





Cryptosporidium
Found at
all sites on map.

Also found in:
Shellfish
in Europe and
U.S. Atlantic and
Gulf Coasts

Annual Manure Production

1997

Animal

Solid manure (tons)

Cattle

1.23 billion

Hogs

117 million

Poultry

19.8 million

Total

1.37 billion

US Senate Committee on Agriculture, Nutrition, & Forestry, 1997

Human waste = ~1/100

Human Waste

Direct discharge ~90% in developing countries (Briscoe 1993)

On site septic systems

Regulated wastewater / sewage treatment facilities

Multiple processes resulting in

Biosolid generation

Liquid effluent generation

Bovine Cryptosporidiosis



C. parvum

C. andersoni

C. bovis

Deer-like genotype

Multistate Survey

No. of calves examined (n=1542)
7 states (VT, NY, PA, MD, VA, NC, and FL)

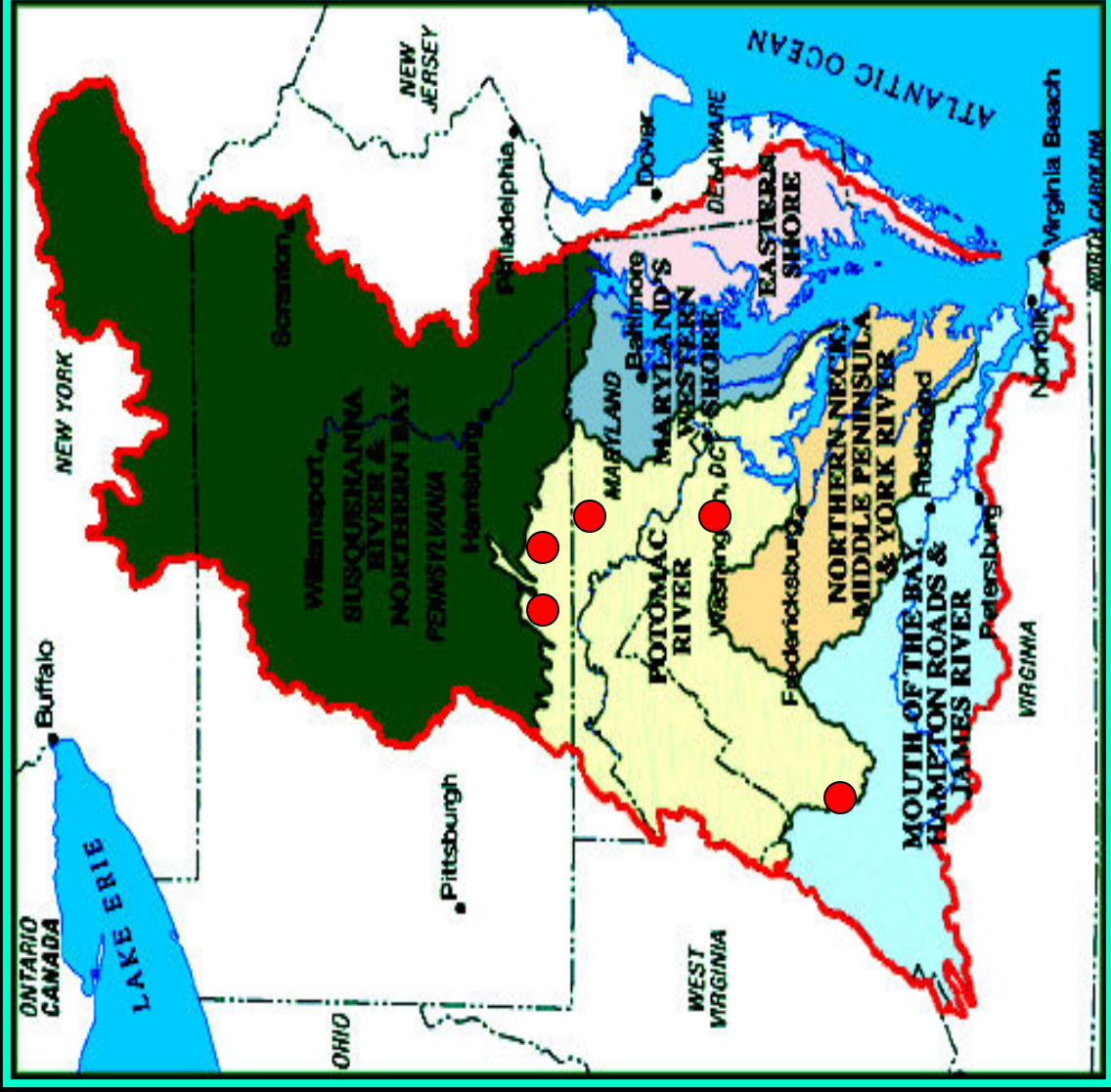


Pre-weaned calves (n=503)
Post-weaned calves (n=468)
12-24 months of age (n=571)

**All PCR positive samples were
sequenced**

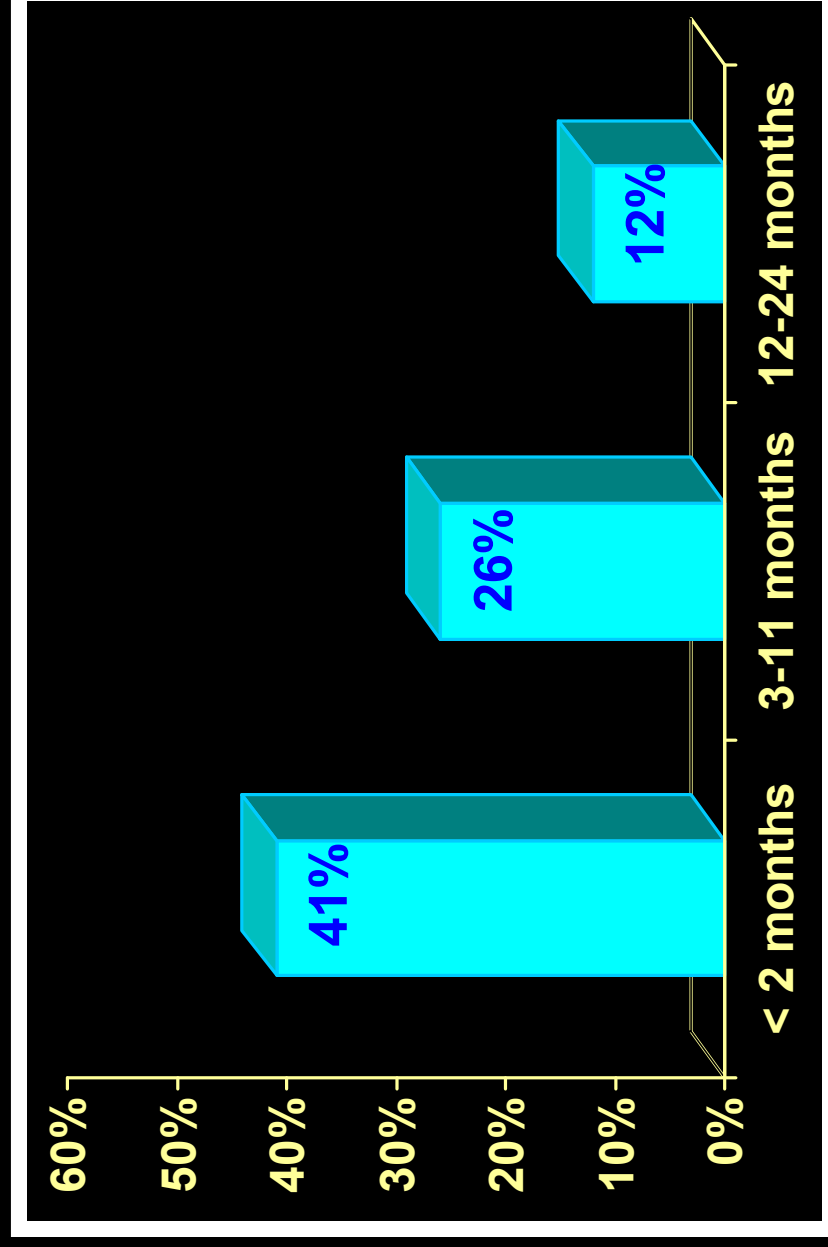
Chesapeake Bay Watershed

Red dots indicate approximate locations in the Potomac Basin of 5 farms that were sampled.



Prevalence by PCR

Overall: 33 % (346/1,411)



Molecular characterization

PCR analysis

Sequencing of a fragment of the 18S rRNA gene

143 *C. parvum*

45 *C. andersoni*

103 *Cryptosporidium bovis*

54 *Cryptosporidium* deer-like genotype

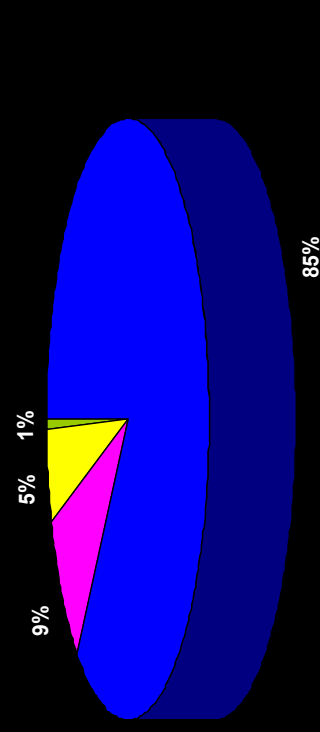
1 *C. suis*

Species/Genotypes Present by Farm

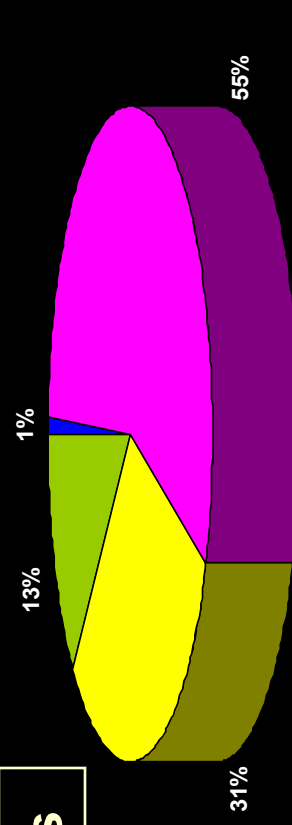
	< 2 months	3-11 months	12-24 months
<i>C. parvum</i>	14	1	3
<i>C. bovis</i>	6	12	8
<i>C. deer-like</i>	6	9	5
<i>C. andersoni</i>	1	6	9
<i>C. suis</i>	0	0	1

Species/Genotypes Present by Age

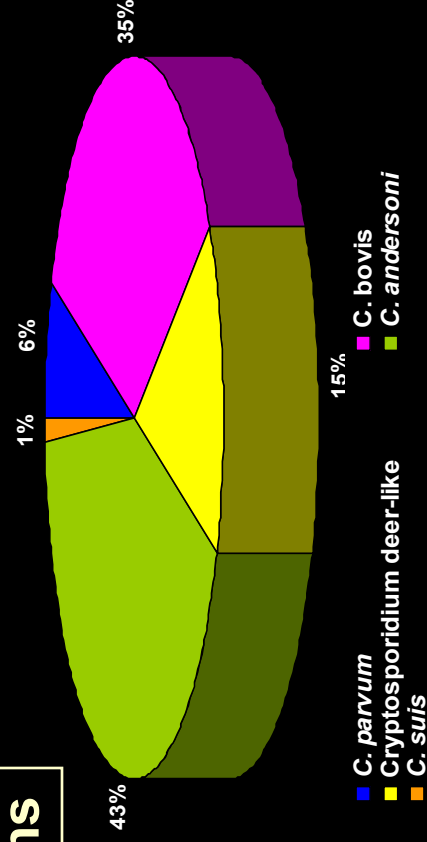
< 2 months



3-11 months



12-24 months



Run Off



Pasture slopes
into river
with direct access

Run Off

Vegetative Buffer Strips (VBS, Riparian buffers)

decrease surface flow rate

prevent run off from directly entering surface water

allow water filter into soil

retain parasites soil spaces

but, some recent research suggests

oocysts might move into ground water

Run Off



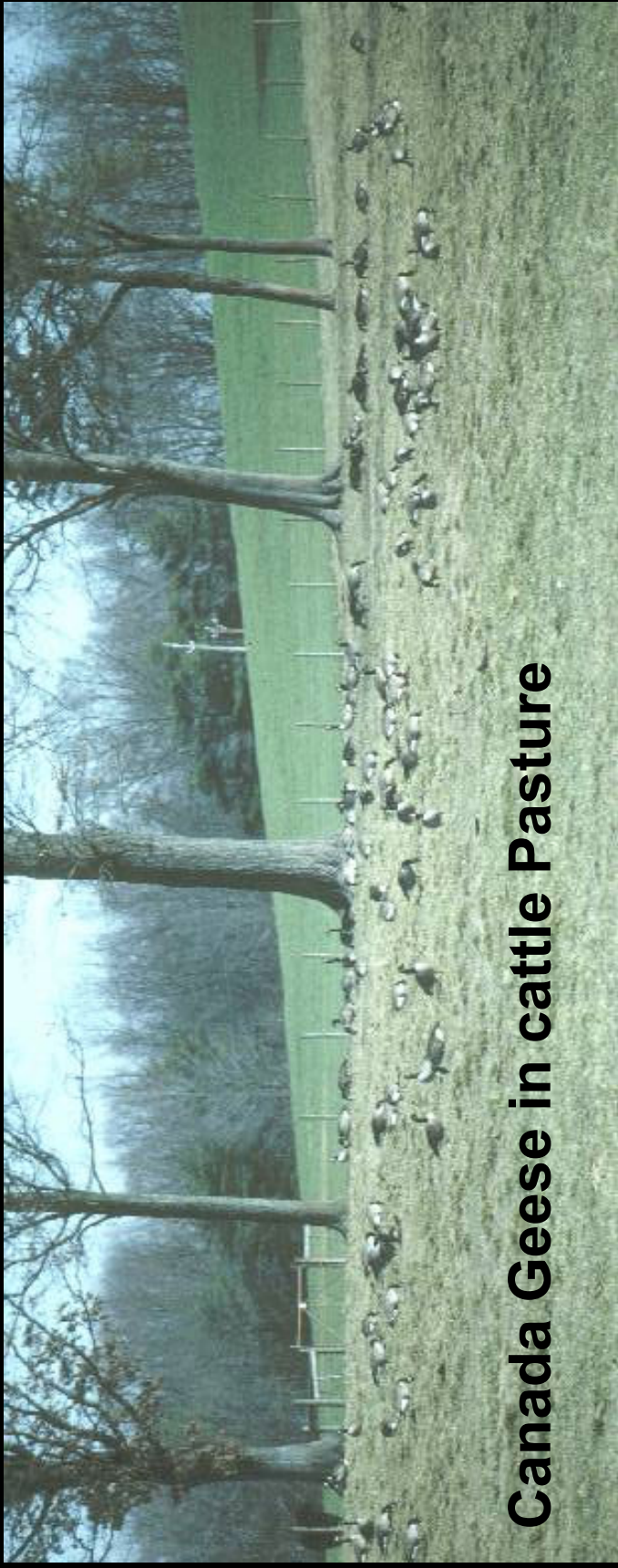
Zoonotic *Cryptosporidium* in Wildlife



Beaver	Deer	Fox	Muskrat	Otter	Raccoon	Coyote
IFA positive						
12%	6%	13%	22%	9%	0	9%
Species / genotype by DNA sequencing						
Beaver	Deer	<i>C. canis</i>	Muskrat	Otter	Raccoon	<i>C. canis</i>

***C. parvum* reported in some wild ruminants in South America**

Mechanical Vectors



Canada Geese in cattle Pasture



Bovine fecal pat
pecked apart

Mechanical Vectors

CANADA GOOSE FECES CONTAIN OOCYSTS AT 7 OF 9 SITES IN CHESAPEAKE BAY AREA

Grasonville 120,000 **

Oxford 1 0

Oxford 2 310,000

Perrys Corner 0

Bryatown, 370,000

Carmichael 710,000

Wye Island 1 620,000

Wye Island 2 1,310,000

Wye Island 3 370,000

*C. parvum**

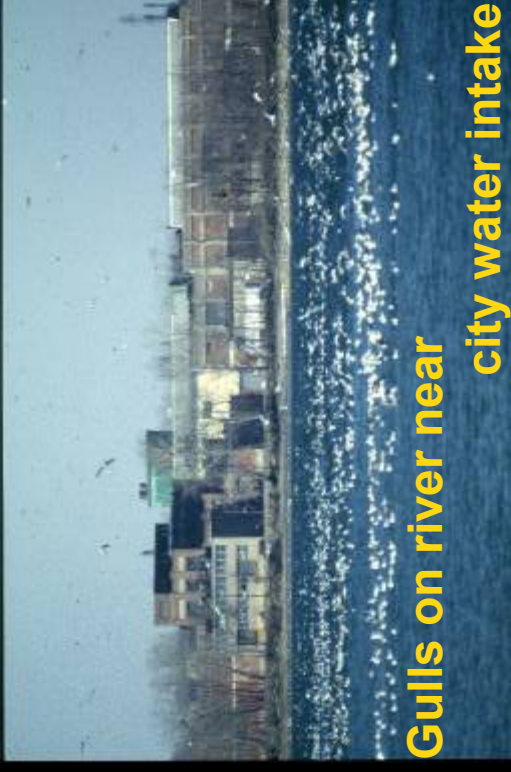
*Based on mouse infection and molecular analysis

** Total oocysts recovered - 300-700/g feces

Mechanical Vectors

Seagulls reported feeding sites:

Abattoirs
Landfills
Pastures
Sewage treatment plants
Sewage discharge sights



Gulls on river near
city water intake

Migratory birds in crop field



Controlling bird access to animals and waste is essential

Summary

Environmental transmission is complex

Oysters are useful indicators of water contamination

Identification of species/genotype is critical

Calves <2 months of age = greatest risk

Controlling runoff may reduce water contamination

Wildlife represent minimal risk

Mechanical vectors should be considered/controlled

Collaborators

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