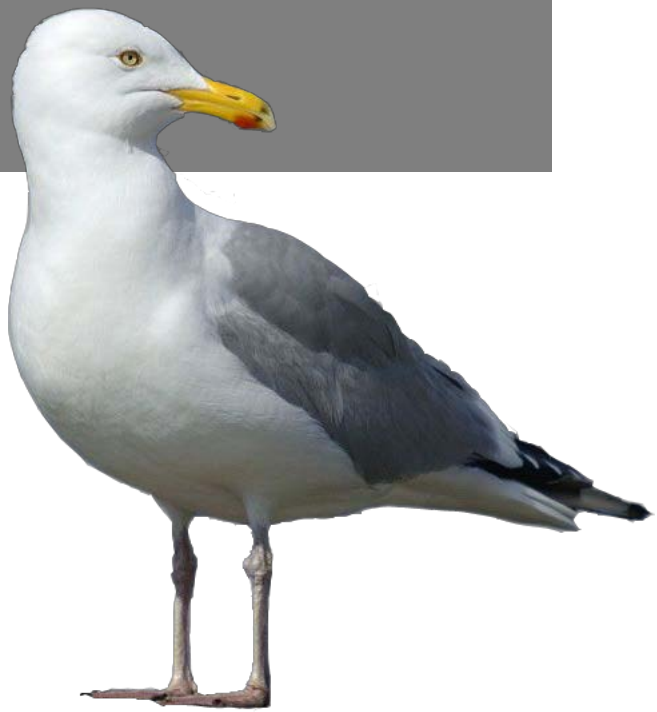
Investigating the emergence, prevalence, and dispersal of antibiotic resistant *E. coli* infecting wild birds in Alaska

Andrew Ramey

US Geological Survey, Alaska Science Center, 4210 University Drive, Anchorage, Alaska 99508



Acknowledgements

Jonas Bonnedahl

Linnæus University

Björn Olsen

UPPSALA UNIVERSITET

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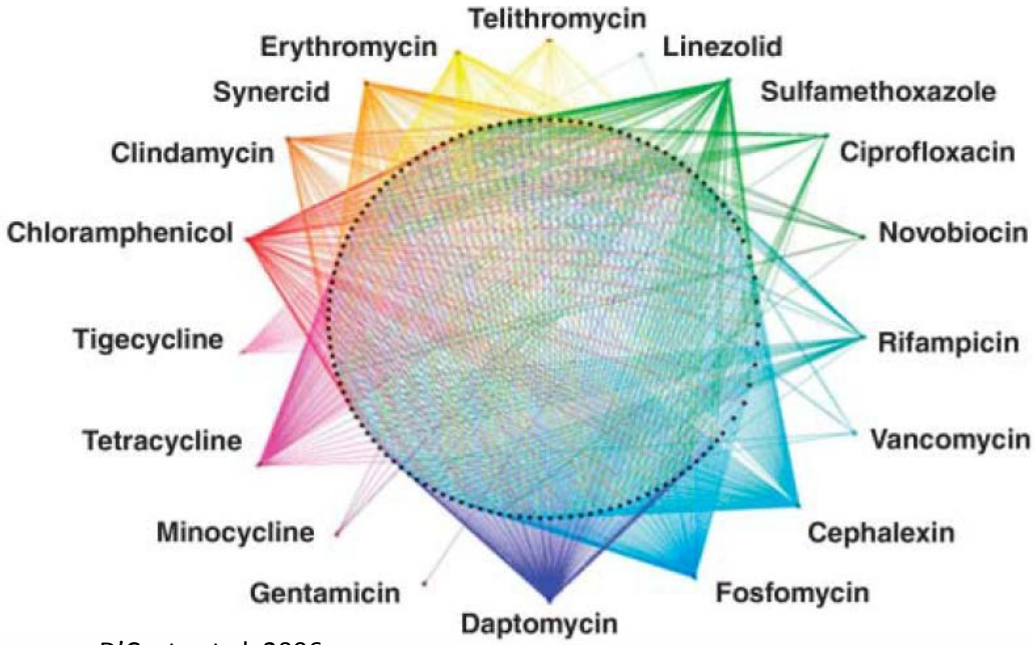
USGS Alaska Science Center
John Reed
Andy Reeves
Lee Tibbits
Matthew Smith

UPPSALA UNIVERSITET

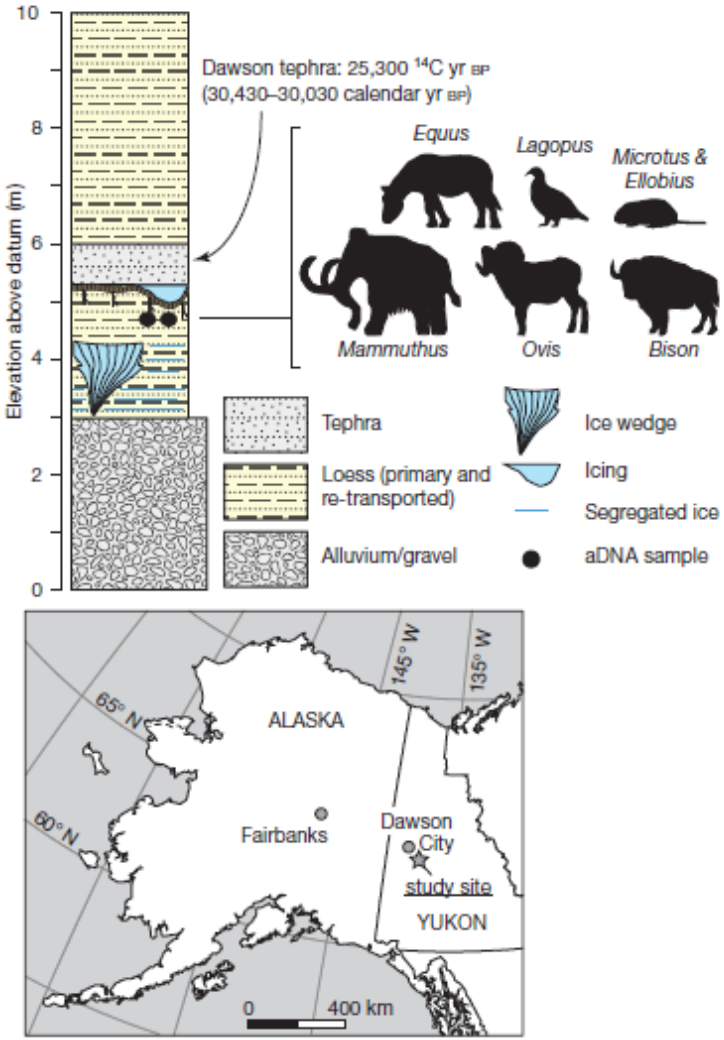
Uppsala University
Clara Atterby
Gabriel Gustafsson Hall
Josef Järhult

SVA

Swedish National Veterinary Institute
Stefan Börjesson



D'Costa et al. 2006



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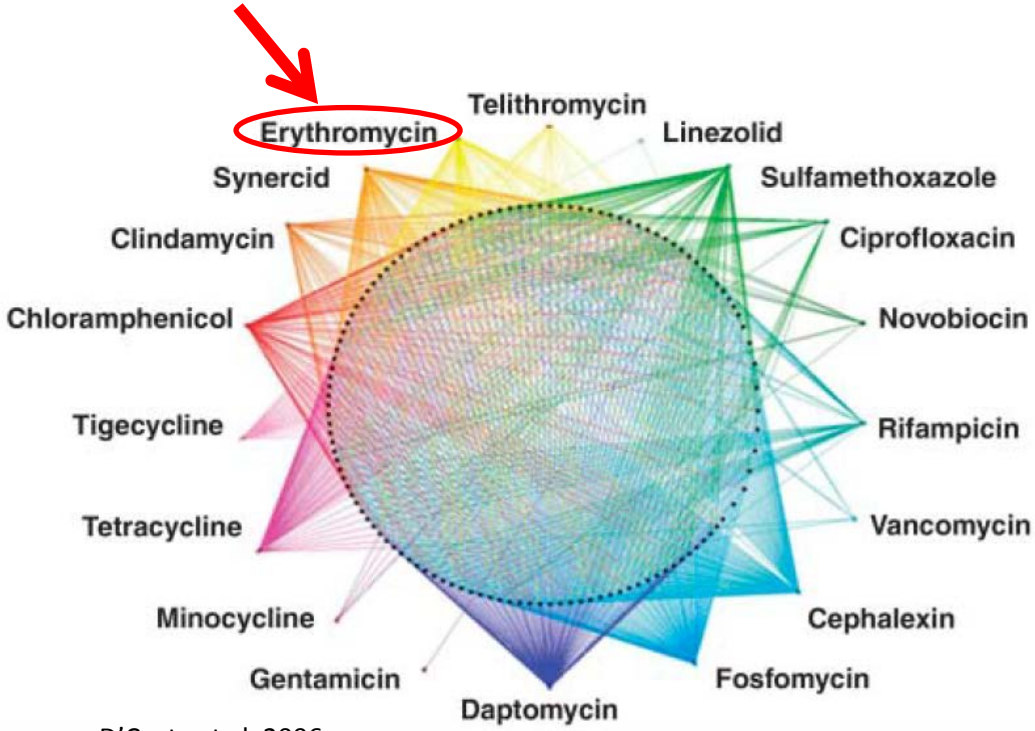

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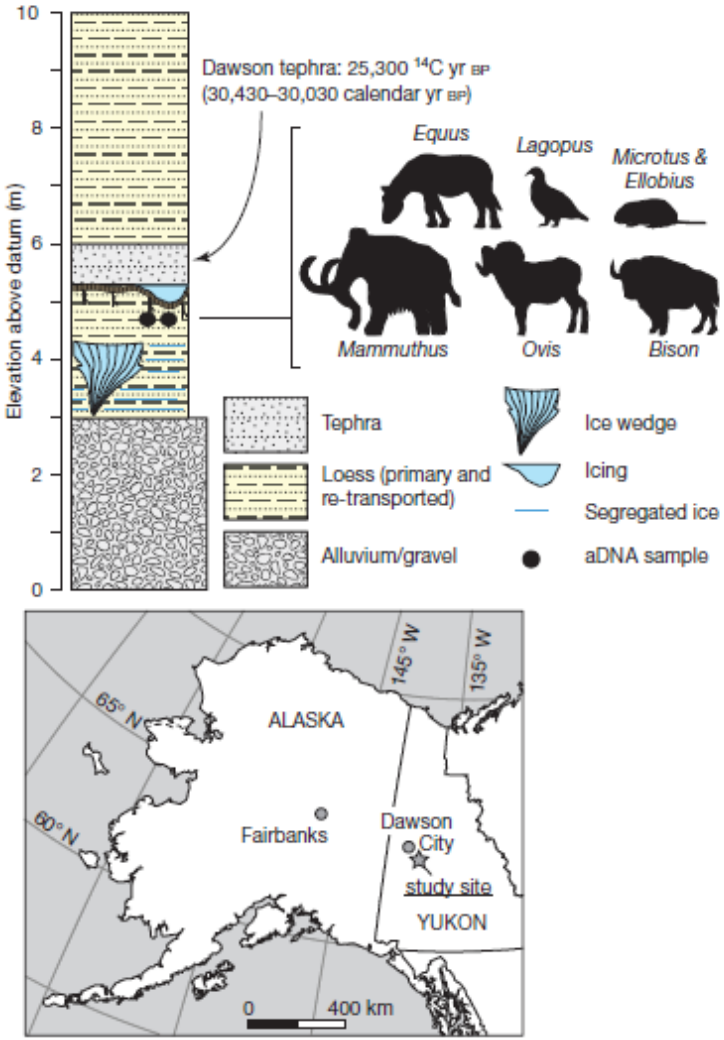

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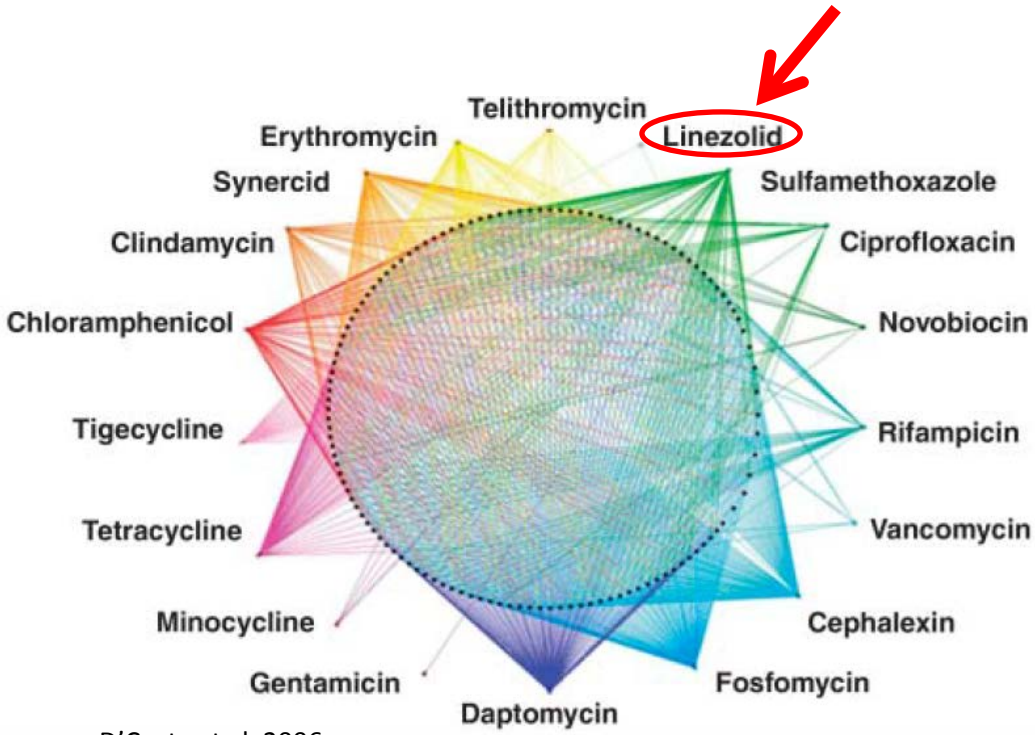

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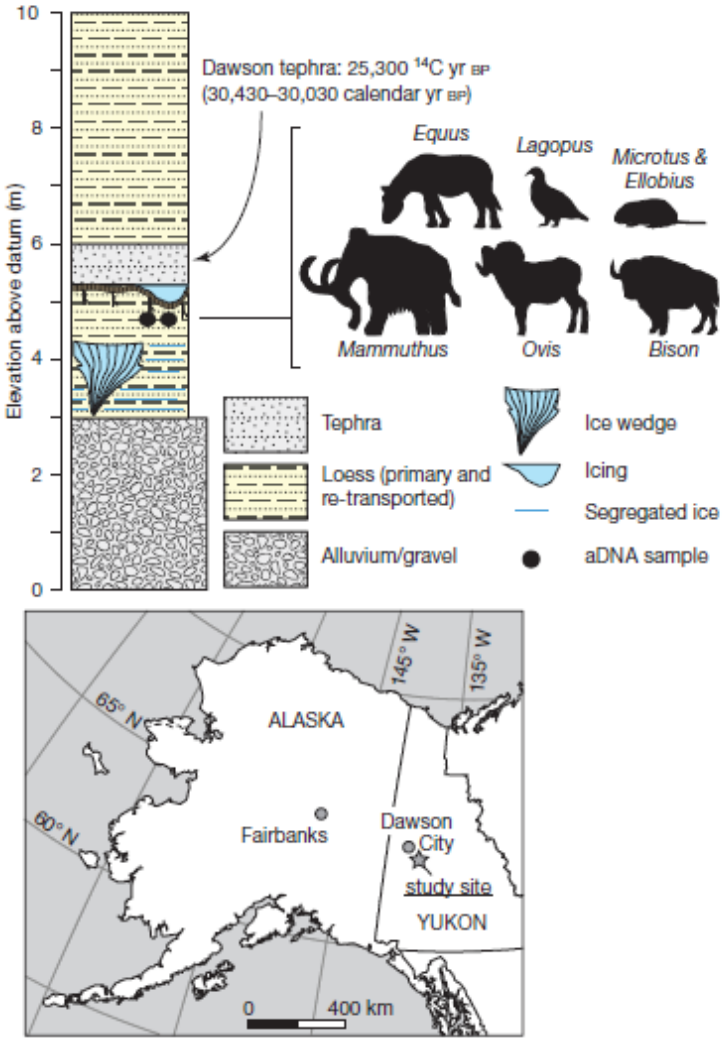

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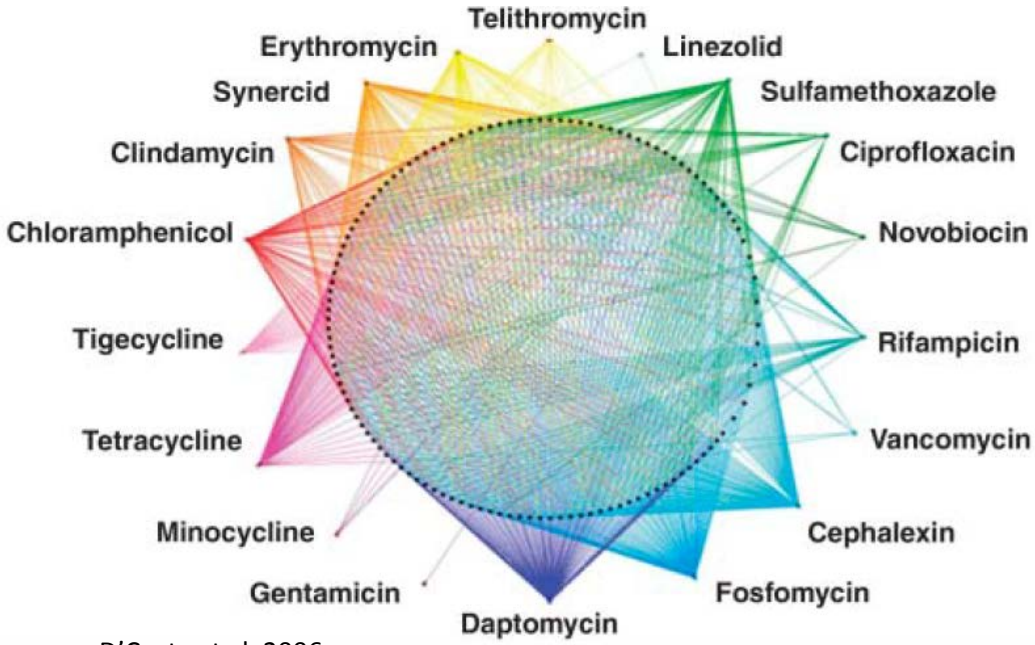
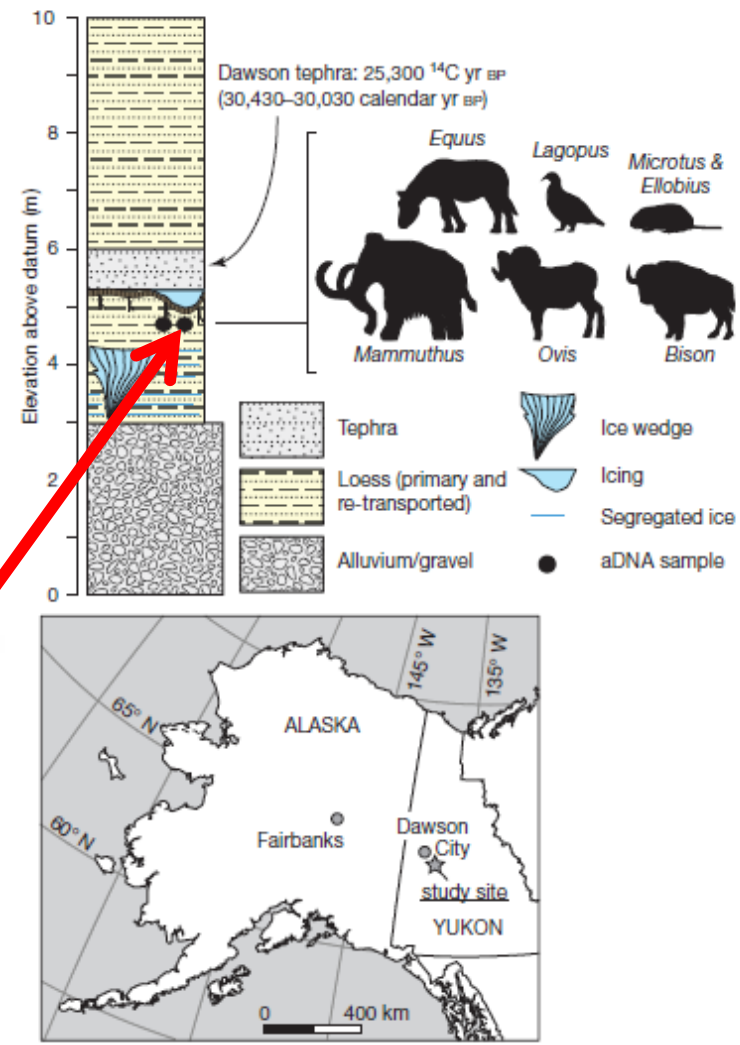


D'Costa et al. 2006

genes encoding resistance to ß-lactam, tetracycline and glycopeptide antibiotics



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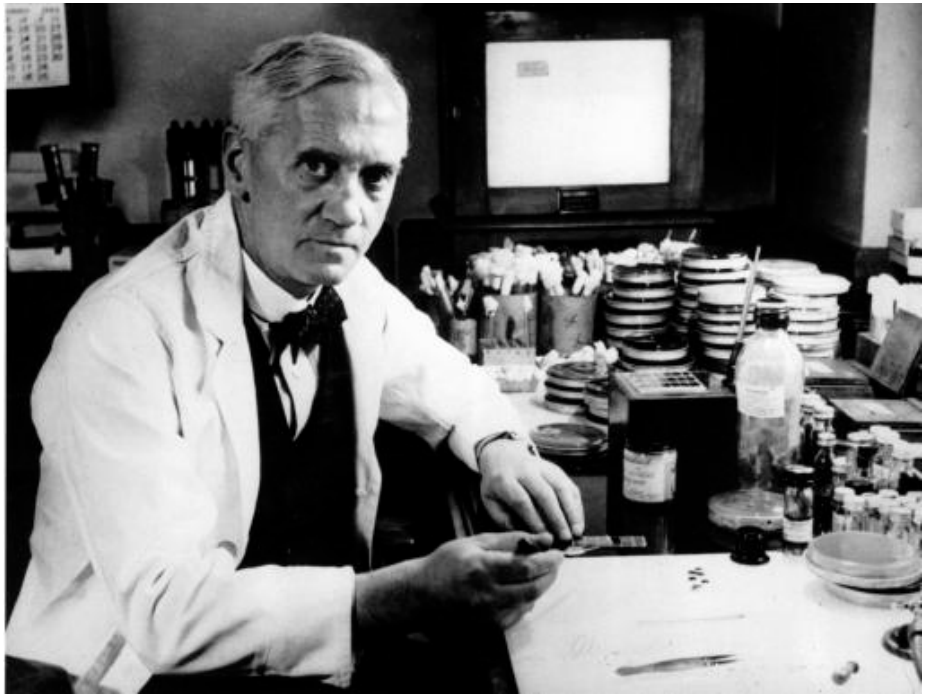

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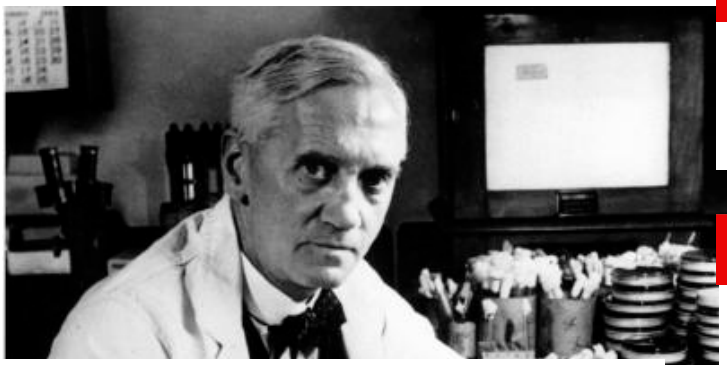

TIME

HEALTH DRUGS

Farm Animals Are Now Resistant to a Last-Resort Antibiotic

TIME

HEALTH DRUGS

Why Drug-Resistance Genes Are Showing Up In Smog

The New York Times

The World Wakes Up to the Danger of Superbugs

By THE EDITORIAL BOARD SEPT. 28, 2016

A technician scanning the X-ray of a patient suspected of having Tuberculosis. Justin Mott for The New York Times

The Washington Post

Early Lead

Report: Studies reveal drug-resistant super bacteria in Rio Olympics water venues

Several bodies of water in Rio that will be used both as leisure spots and Olympic event sites contain antibiotic-resistant super bacteria. (AP Photo/Silvia Izquierdo, File)

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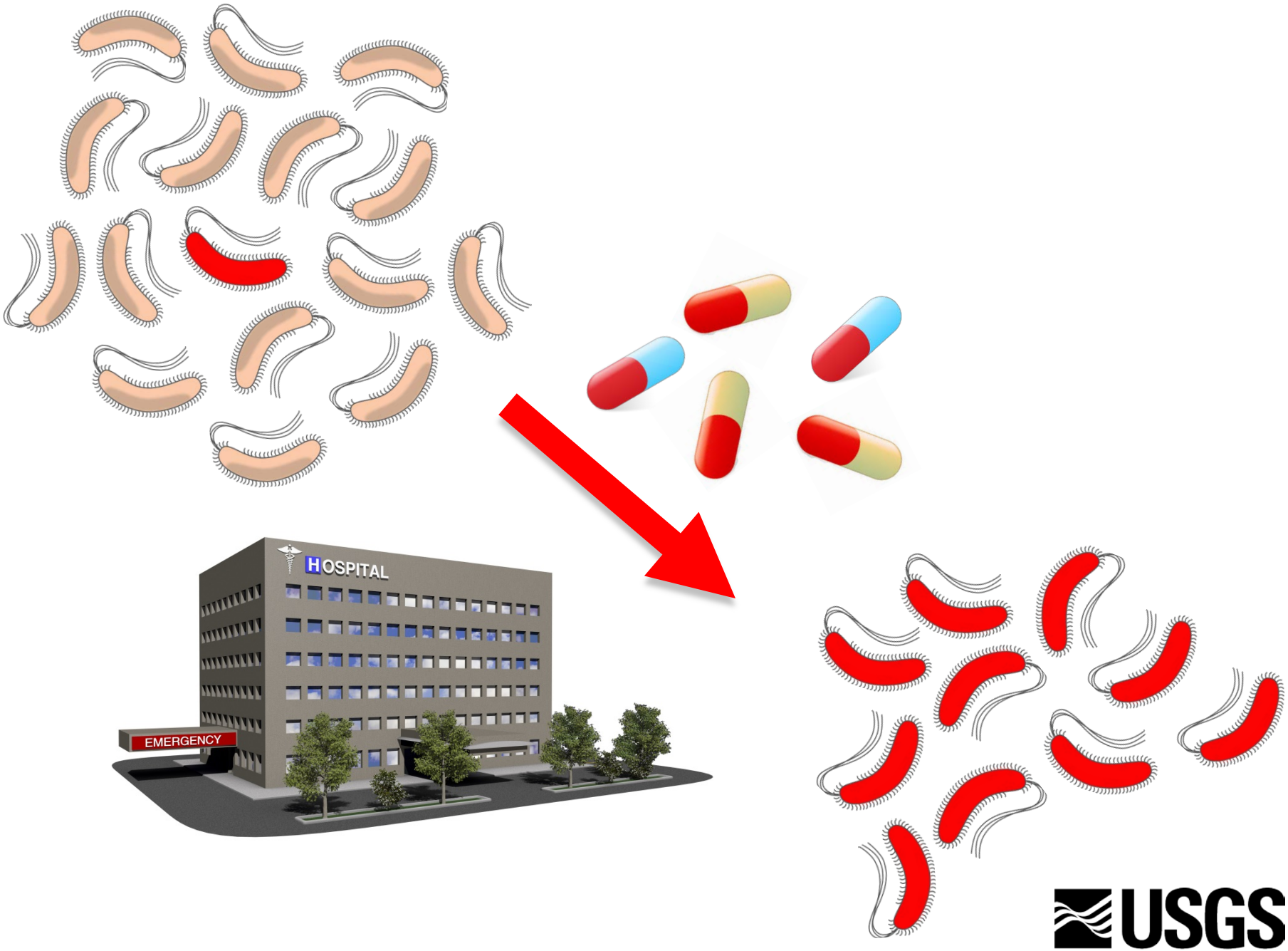

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BLEACH
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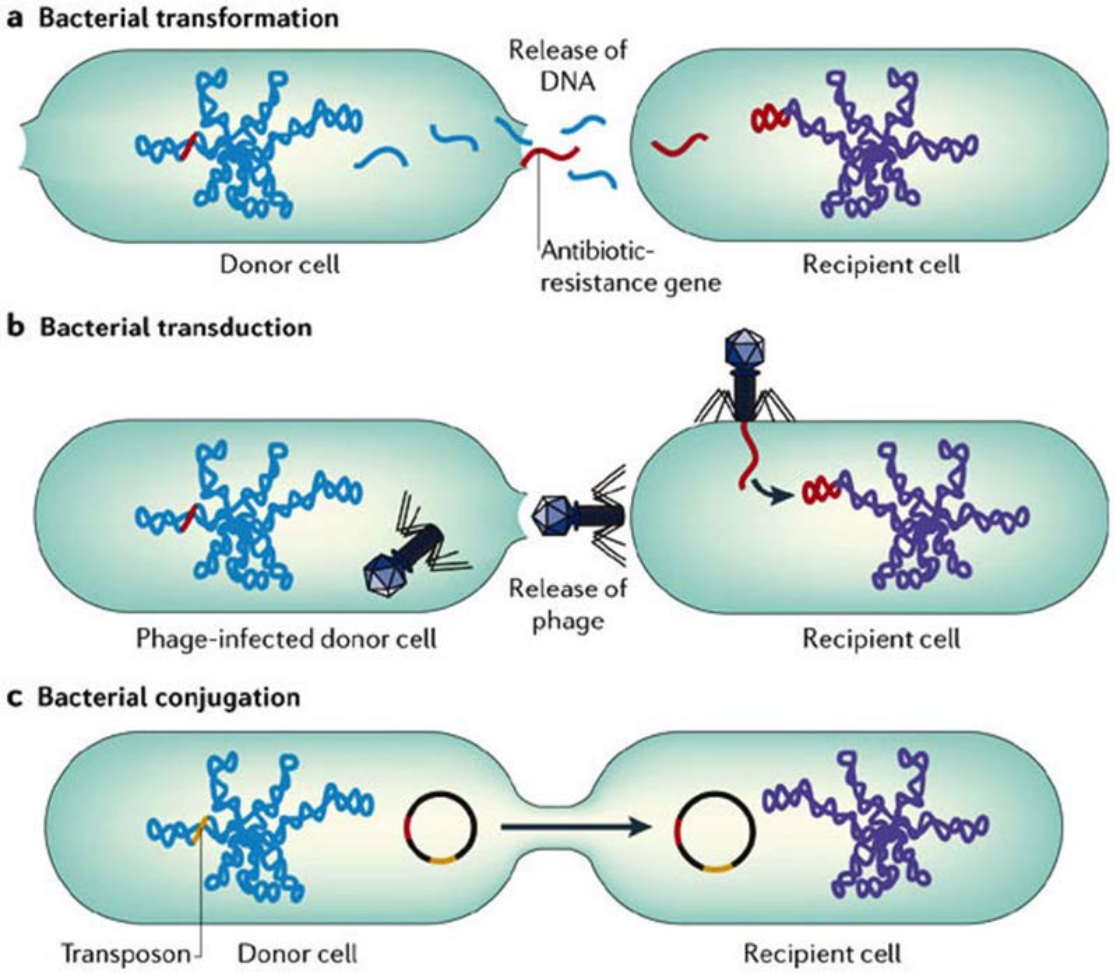

Furuya and Lowy 2006

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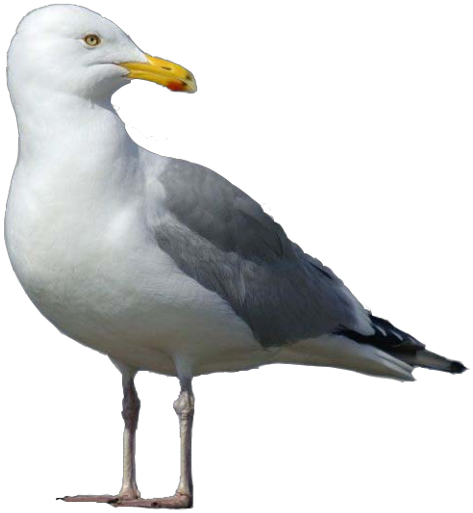
High prevalence of antimicrobial-resistant genes and integrons in *Escherichia coli* isolates from Black-headed Gulls in the Czech Republic

M. Dolejska[1], A. Cizek[1] and I. Literak[2]



RESEARCH Open Access

CrossMark

Carriage of CTX-M type extended spectrum β-lactamases (ESBLs) in gulls across Europe

Johan Stedt[1], Jonas Bonnedahl[2,3], Jorge Hernandez[3], Jonas Waldenström[1], Barry J. McMahon[4], Conny Tolf[1], Björn Olsen[3] and Mirva Drobni[3,5*]

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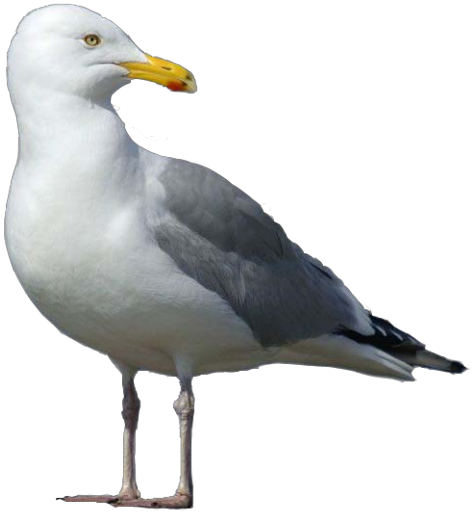

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Multilocus Sequence Typing Confirms Wild Birds as the Source of a *Campylobacter* Outbreak Associated with the Consumption of Raw Peas

Patrick S. L. Kwan,[a] Catherine Xavier,[d] Monica Santovenia,[a] Janet Pruckler,[a] Steven Stroika,[a] Kevin Joyce,[a] Tracie Gardner,[c] Patricia I. Fields,[a] Joe McLaughlin,[d] Robert V. Tauxe,[b] Collette Fitzgerald[a]

STUDY OF THE BACTERIAL CONTENT OF RING-BILLED GULL DROPPINGS IN RELATION TO RECREATIONAL WATER QUALITY

BENOÎT LÉVESQUE[1]*, PIERRE BROUSSEAU[2], FRANCE BERNIER[3], ÉRIC DEWAILLY[1] and JEAN JOLY[3]

THE CONTAMINATION OF A MAJOR WATER SUPPLY BY GULLS (*LARUS* sp.)

A STUDY OF THE PROBLEM AND REMEDIAL ACTION TAKEN

C. BENTON[1], F. KHAN[1], P. MONAGHAN[2], W. N. RICHARDS[1] and C. B. SHEDDEN[2]

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Evidence for intercontinental parasite exchange through molecular detection and characterization of haematozoa in northern pintails (*Anas acuta*) sampled throughout the North Pacific Basin

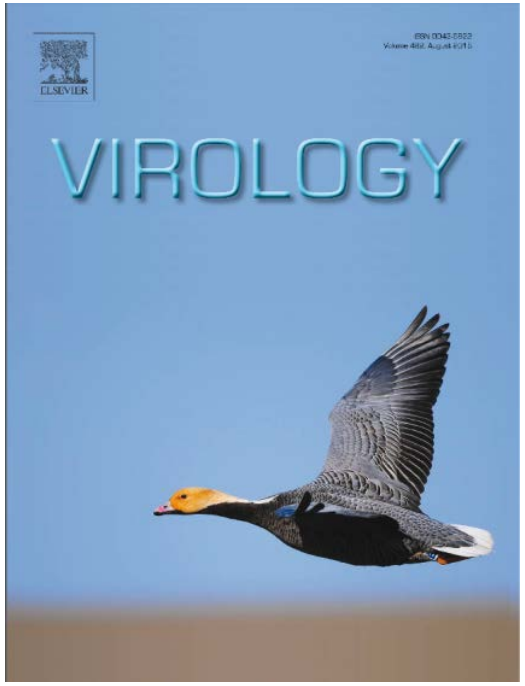
Andrew M. Ramey [a,b,*], Joel A. Schmutz [a], John A. Reed [a], Go Fujita [c], Bradley D. Scotton [d], Bruce Casler [e], Joseph P. Fleskes [f], Kan Konishi [g], Kiyoshi Uchida [h], Michael J. Yabsley [b,i]

Dispersal of H9N2 influenza A viruses between East Asia and North America by wild birds

Andrew M. Ramey [a,*], Andrew B. Reeves [a], Sarah A. Sonsthagen [a], Joshua L. TeSlaa [b], Sean Nashold [b], Tyrone Donnelly [a], Bruce Casler [c], Jeffrey S. Hall [b]

Genetic diversity and mutation of avian paramyxovirus serotype 1 (Newcastle disease virus) in wild birds and evidence for intercontinental spread

Andrew M. Ramey · Andrew B. Reeves · Haruko Ogawa · Hon S. Ip · Kunitoshi Imai · Vuong Nghia Bui · Emi Yamaguchi · Nikita Y. Silko · Claudio L. Afonso



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PLOS | ONE

RESEARCH ARTICLE

Comparison of Extended-Spectrum β-Lactamase (ESBL) CTX-M Genotypes in Franklin Gulls from Canada and Chile

Jonas Bonnedahl[1,2]*, Johan Stedt[1], Jonas Waldenström[1], Lovisa Svensson[1], Mirva Drobni[3], Björn Olsen[3]

country	% of *E. coli*
Spain	75%
France	47%
Netherlands	38%
Chile	30%
Czech Republic	29%
England	27%
Sweden	21%
Latvia	17%
Portugal	13%
Ireland	5%
Poland	1%
Denmark	0%

Data taken from: Dolejska et al. 2007, Bonnedahl et al. 2009, Hernandz et al. 2013, Stedt et al. 2015

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INTERNATIONAL POLAR YEAR

Dissemination of Multidrug-Resistant Bacteria into the Arctic

Maria Sjölund,*[1] Jonas Bonnedahl,† Jorge Hernandez,‡ Stina Bengtsson,* Gunilla Cederbrant,* Jarone Pinhassi,‡ Gunnar Kahlmeter,*§ and Björn Olsen‡§

We show that *Escherichia coli* isolates originating from Arctic birds carry antimicrobial drug resistance determinants. This finding implies that dissemination of drug-resistant bacteria is worldwide. Resistance genes can be found even in a region where no selection pressure for resistance development exists.

Data taken from: Dolejska et al. 2007, Bonnedahl et al. 2009, Hernandz et al. 2013, Stedt et al. 2015

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LETTERS

Extended-Spectrum β-Lactamases in *Escherichia coli* and *Klebsiella pneumoniae* in Gulls, Alaska, USA

To the Editor: Resistance to β-lactam antibacterial drugs has spread rapidly, particularly through the CTX-M β-lactamase enzymes (CTX-M) (*1*). Although CTX-Ms are geographically widely distributed, reports of extended-spectrum β-lactamase (ESBL) dissemination are few from remote regions.

Data taken from: Dole l. 2013, Stedt et al. 2015

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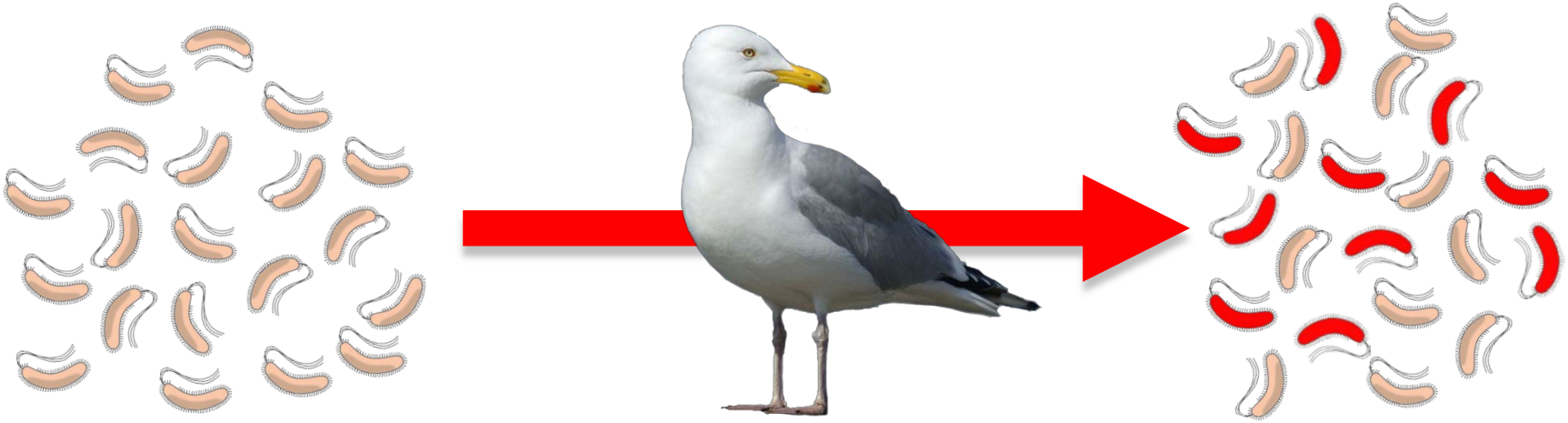

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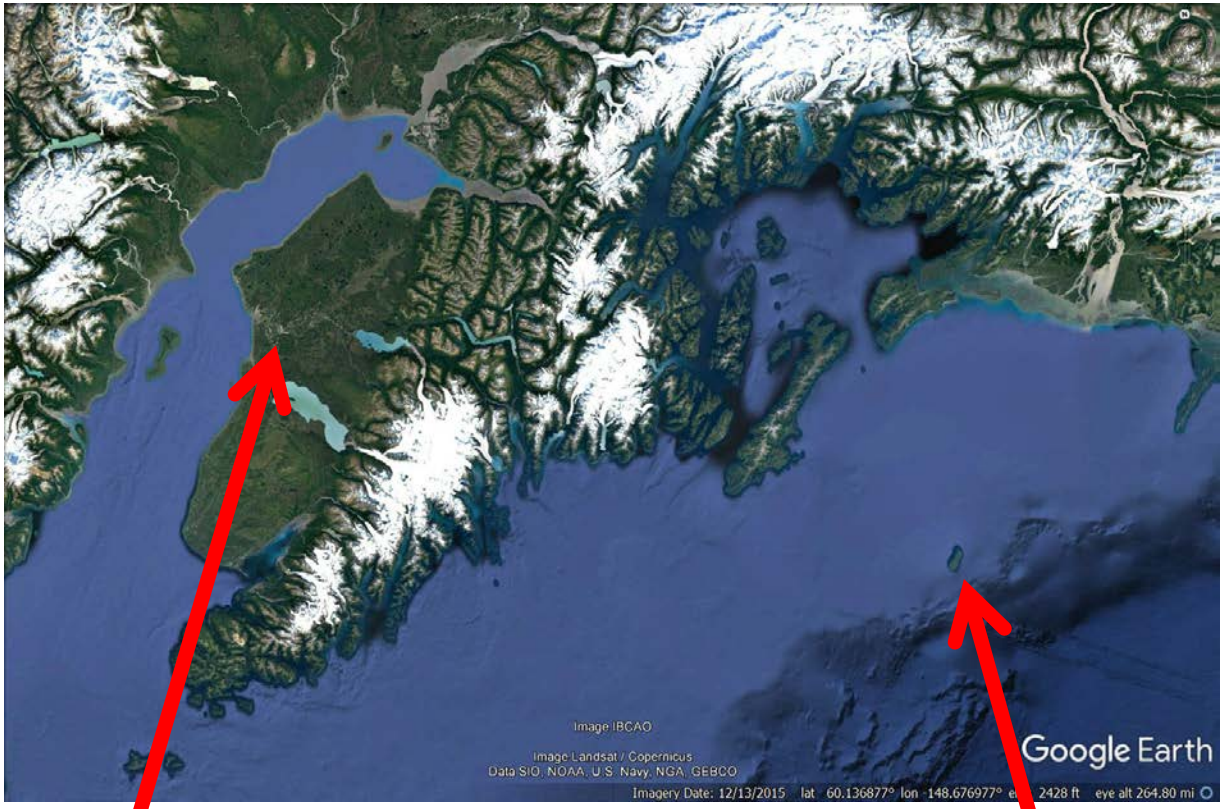

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Location	Isolates (n =)	Number of compounds *E. coli* resistant to:									
		1	2	3	4	5	6	7	8	9	10
Kenai Peninsula (urban)	55	4	14	4	3	1	1	2	1	0	0
Middleton Island (remote)	60	2	2	1	0	0	0	0	0	0	0

Atterby et al. 2016

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Location	Isolates (n =)	Number of compounds *E. coli* resistant to: 1	2	3	4	5	6	7	8	9	10	
Kenai Peninsula (urban)	55	4	14	4	3	1	1	2	1	0	0	**30/55 = 55%**
Middleton Island (remote)	60	2	2	1	0	0	0	0	0	0	0	**5/60 = 8%**

Atterby et al. 2016

***significant Kenai Peninsula vs Middleton Island, P value <0.0001, two-tailed Fisher's exact test

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Location	Isolates (n =)	Number of compounds *E. coli* resistant to: 1	2	3	4	5	6	7	8	9	10	
Kenai Peninsula (urban)	55	4	14	4	3	1	1	2	1	0	0	**12/55 = 22%**
Middleton Island (remote)	60	2	2	1	0	0	0	0	0	0	0	**1/60 = 2%**

Atterby et al. 2016

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Atterby et al. 2016

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Kenai Pe 2/55 = 22%

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Middleto /60 = 2%

(remot

Atterby et al.

and, P value

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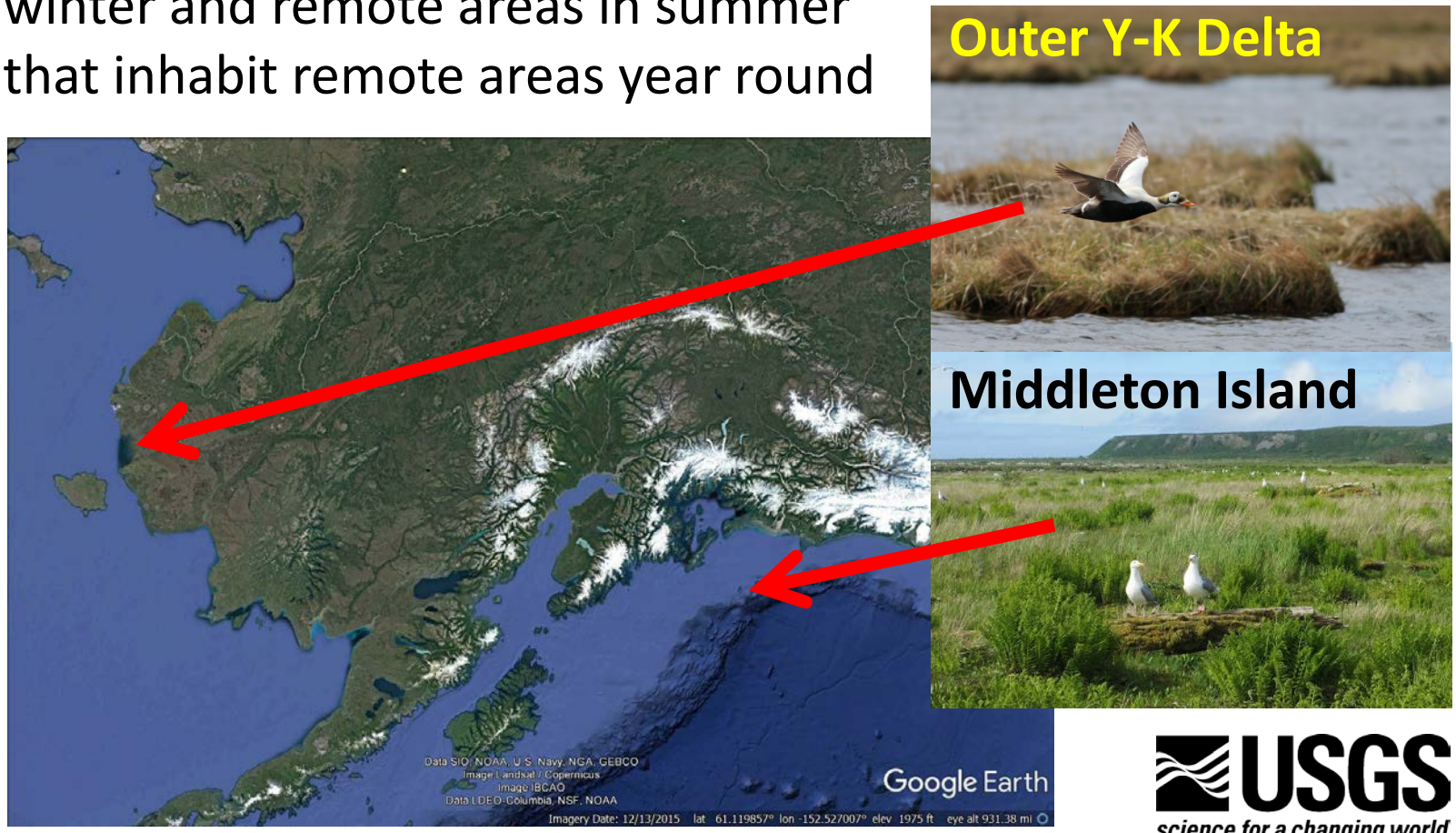
Pilot project on ABR bacteria dispersal by migratory birds

- sample at two remote areas: outer Yukon-Kuskokwim Delta and Middleton Island
- compare prevalence of ABR *E. coli* in species:
  1. that use anthropogenically influenced habitats in winter and remote areas in summer
  2. that inhabit remote areas year round



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Potential outcomes:

1. higher prevalence of antibiotic resistant *E. coli* in species that winter in anthropogenically influenced habitats as compared to sympatric species that inhabit remote areas of North America year-round
2. equally low prevalence of antibiotic resistant *E. coli* in species with contrasting life histories
3. equally high prevalence of antibiotic resistant bacteria in species with contrasting life histories

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Results: Outer Yukon-Kuskokwim Delta…

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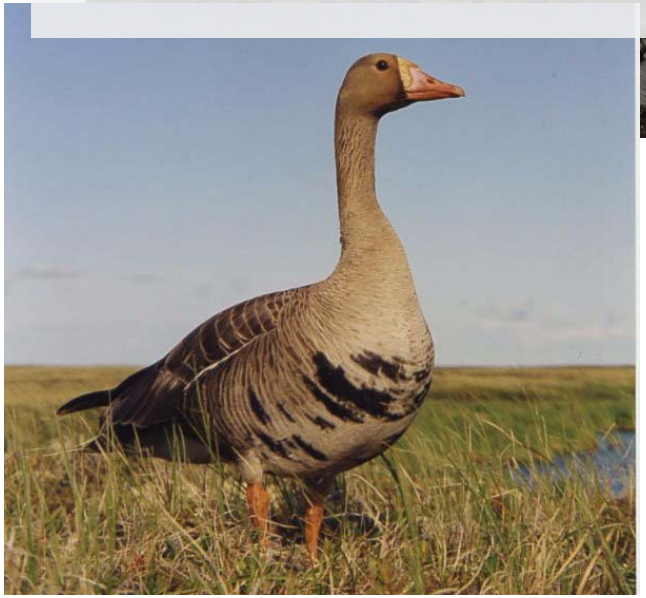
Results: Outer Yukon-Kuskokwim Delta…

No evidence for antibiotic resistant *E. coli* phenotypes



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Results: Middleton Island…

BLKI

GWGU

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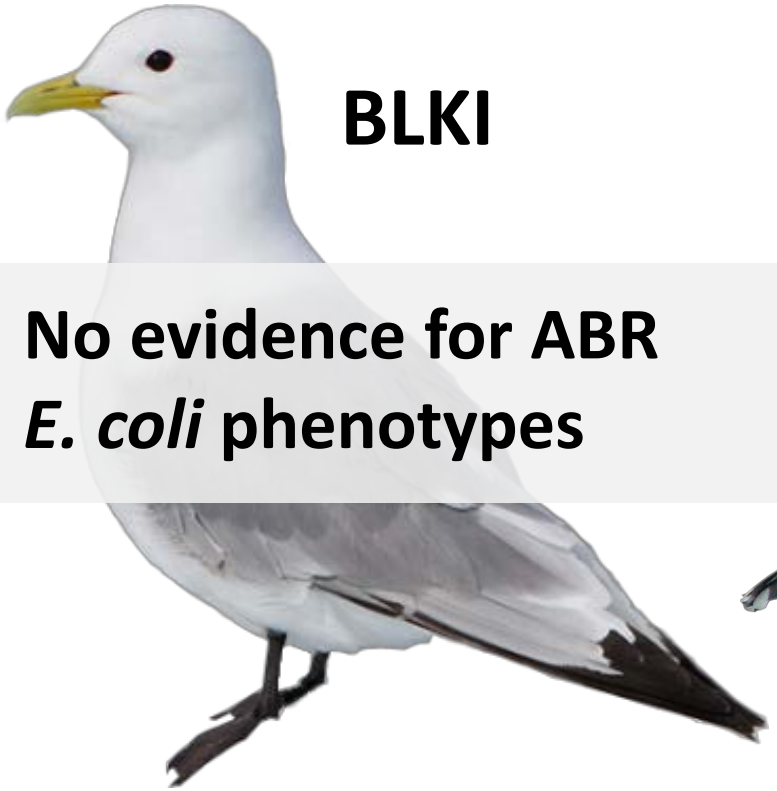
Results: Middleton Island…



BLKI

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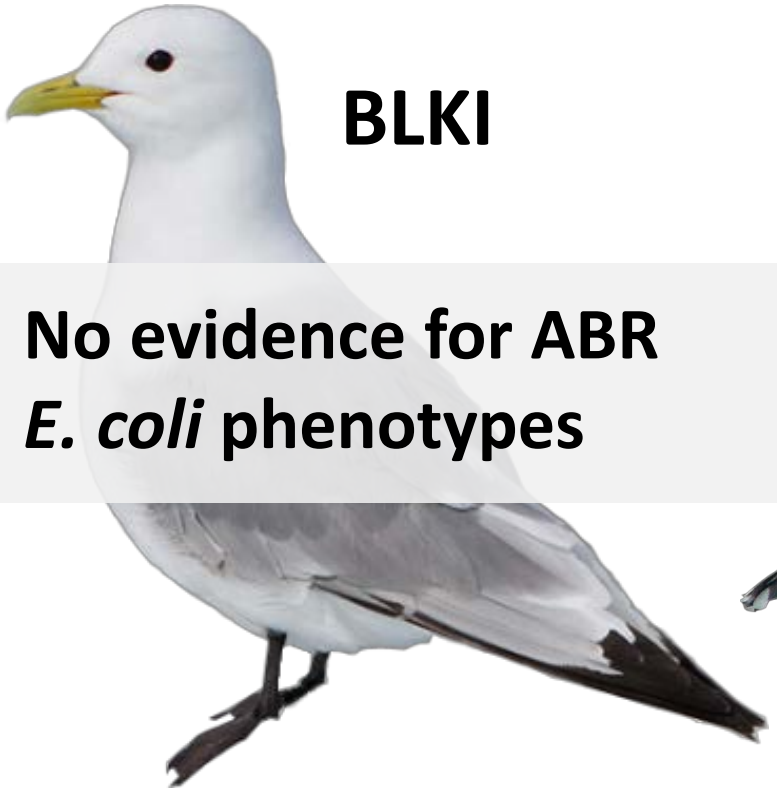

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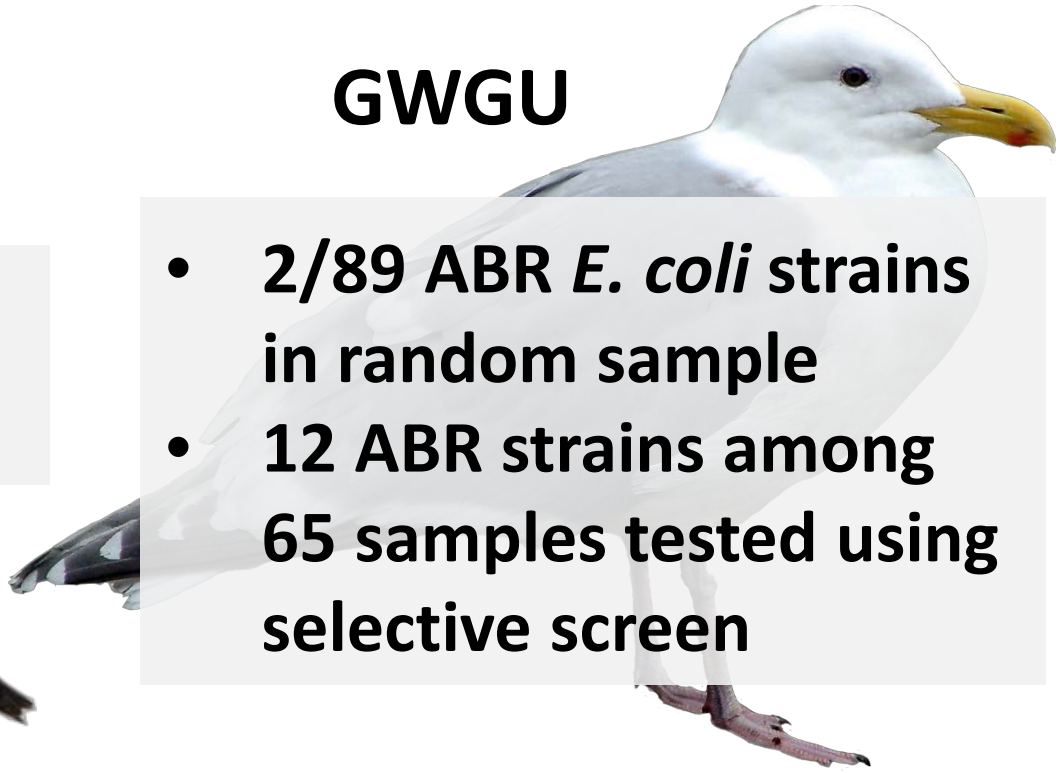

GWGU

- 2/89 ABR *E. coli* strains in random sample
- 12 ABR strains among 65 samples tested using selective screen

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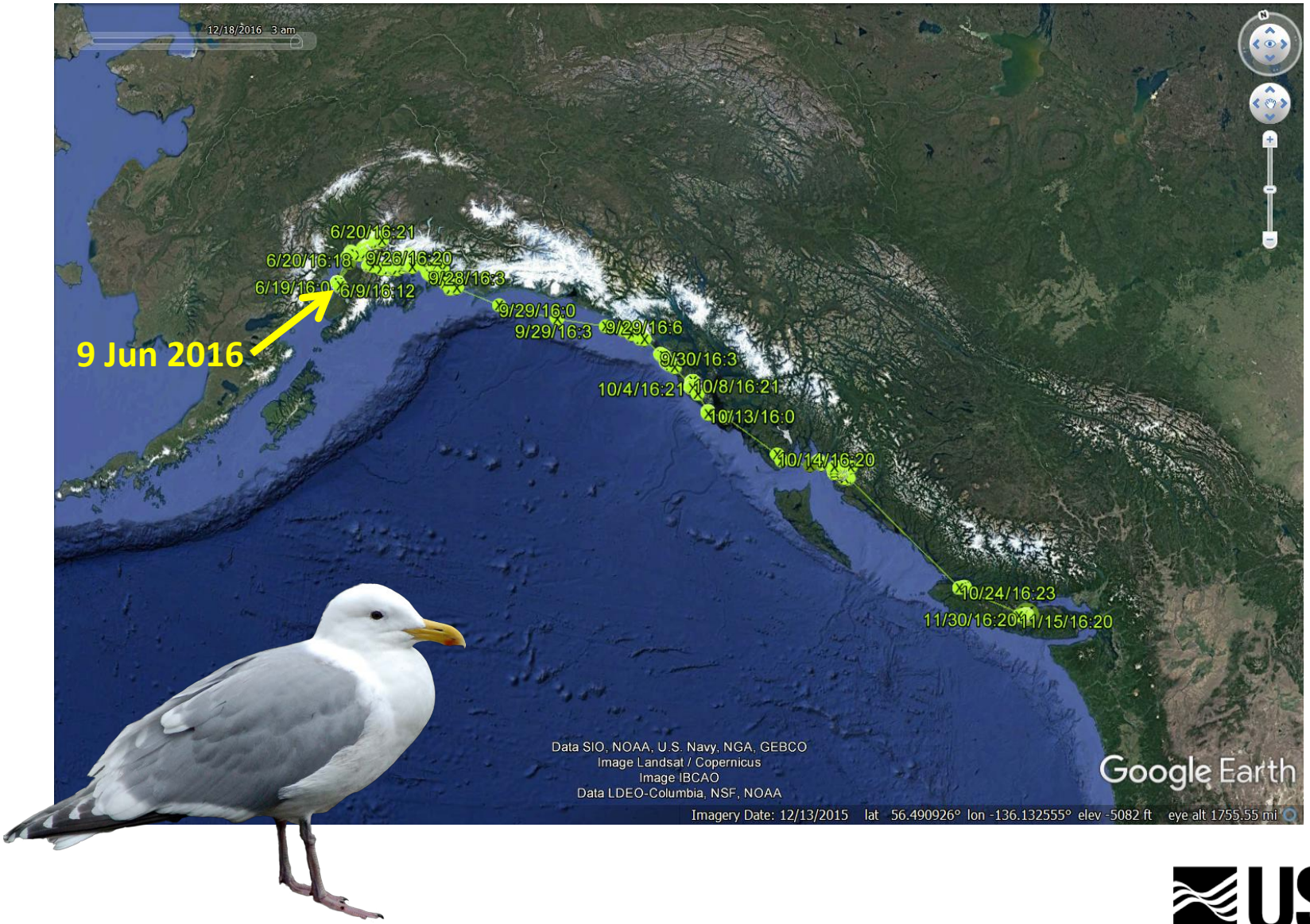
GWGU #161866



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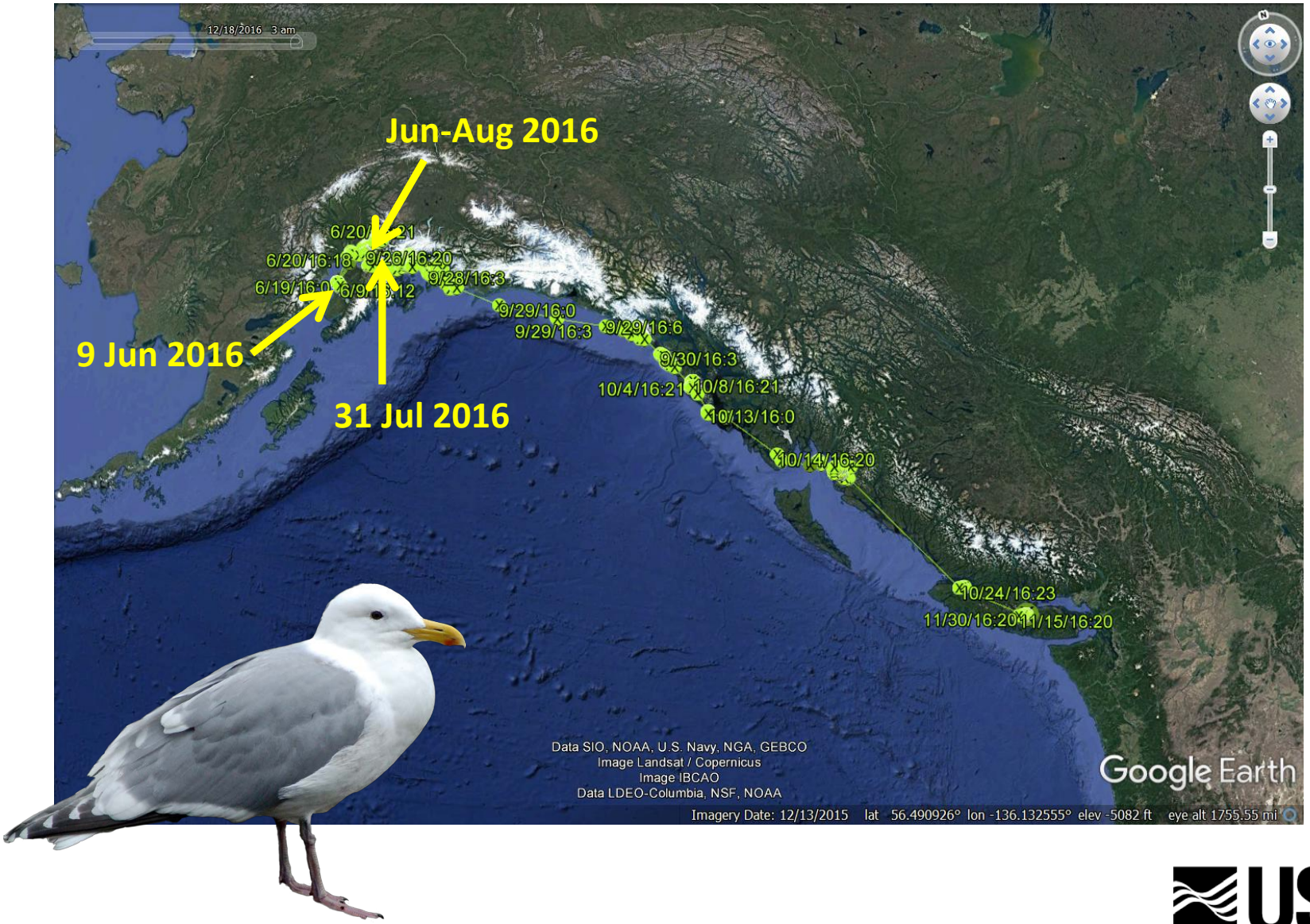

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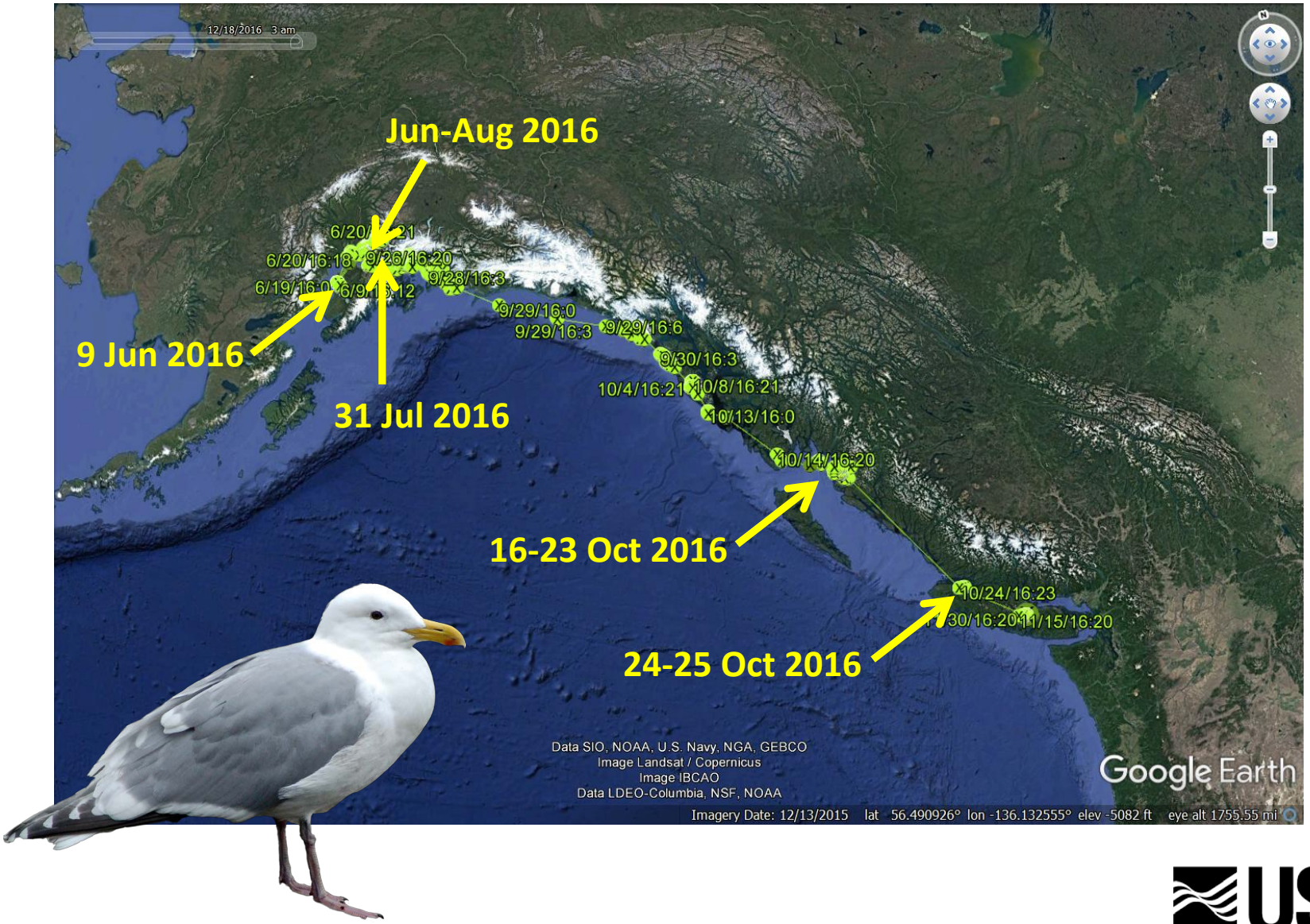

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GWGU #161866

Antimicrobial Resistance in Generic *Escherichia coli* Isolates from Wild Small Mammals Living in Swine Farm, Residential, Landfill, and Natural Environments in Southern Ontario, Canada[▽]

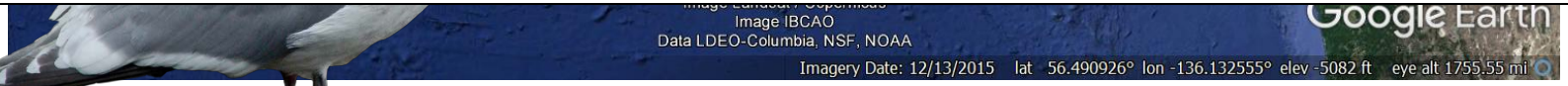
Samantha E. Allen,[1] Patrick Boerlin,[1] Nicol Janecko,[2] John S. Lumsden,[1] Ian K. Barker,[1] David L. Pearl,[2] Richard J. Reid-Smith,[2,3] and Claire Jardine[1]*

Department of Pathobiology[1] and Department of Population Medicine,[2] Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada, and Laboratory for Foodborne Zoonoses, Public Health Agency of Canada, Guelph, Ontario, Canada[3]

Antibiotic-Resistant Bacteria in Wild Primates: Increased Prevalence in Baboons Feeding on Human Refuse

ROSALIND M. ROLLAND,[1] GLENN HAUSFATER,[2]† BONNIE MARSHALL,[1] AND STUART B. LEVY[1,3]*

Departments of Molecular Biology and Microbiology[1] and Medicine,[3] Schools of Medicine and of Veterinary Medicine, Tufts University, Boston, Massachusetts 02111, and Section of Neurobiology and Behavior, Division of Biological Sciences, Cornell University, Ithaca, New York 14853[2]



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Ongoing/future work:

Local scale – research questions

1. How does prevalence of ABR *E. coli* in gulls at the mouths of the Kenai and Kasilof rivers compare to sites at the Soldotna landfill and the Upper Kenai River?
2. Is there evidence that ABR *E. coli* are dispersed by gulls between the Soldotna landfill and areas where people participate in personal-use fisheries?
3. Is there evidence for a seasonal peak in prevalence of ABR *E. coli* in gulls in the Kenai and Kasilof river watersheds and how does that relate in space/time with personal-use fisheries?

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Ongoing/future work:

Local scale – research activities

- Mark 15 gulls with satellite transmitters at Soldotna landfill
- Sample gull feces at Upper Kenai River, Lower Kenai River, Lower Kasilof River, and Soldotna landfill during summer
- Sample exterior and interior surfaces of fish harvested in personal-use fisheries

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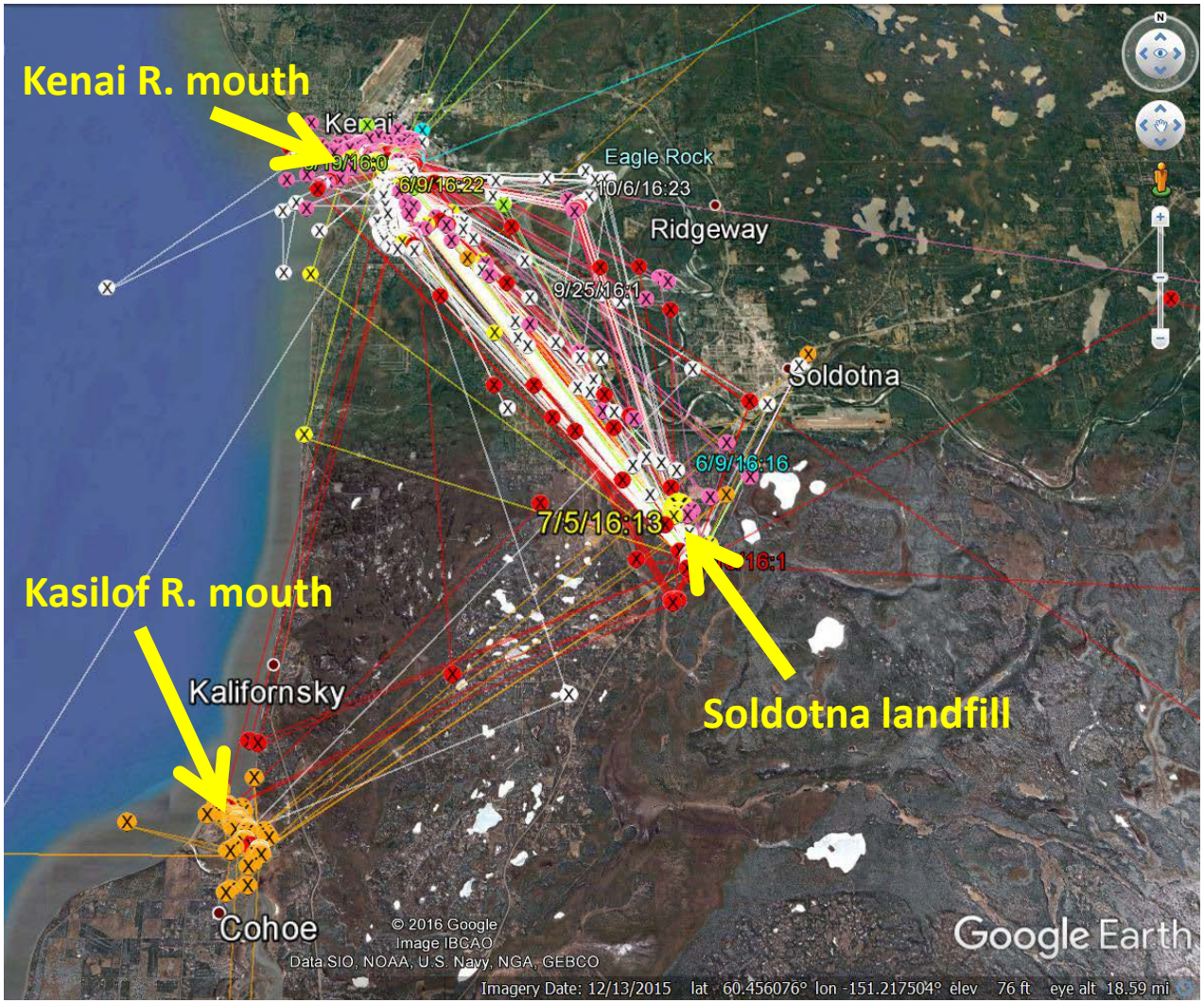
Ongoing/future work:

Preliminary satellite transmitter data (n = 7)



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Ongoing/future work:

Regional scale – research questions

1. What is the relationship between the population of local human communities and the prevalence of ABR *E. coli* in spatially proximate populations of large gulls in Alaska?
2. Is there evidence for dispersal of ABR *E. coli* among gull populations within Alaska?

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Ongoing/future work:

Regional scale – research activities

- Sample gull feces at Adak, Anchorage, Bethel, Cold Bay, Nome, Soldotna, Unalaska, and Utqiaġvik in June and August of 2016/2017
- Phenotypically/genetically characterize resultant *E. coli* isolates
- Instrument large gulls at each location with satellite transmitters

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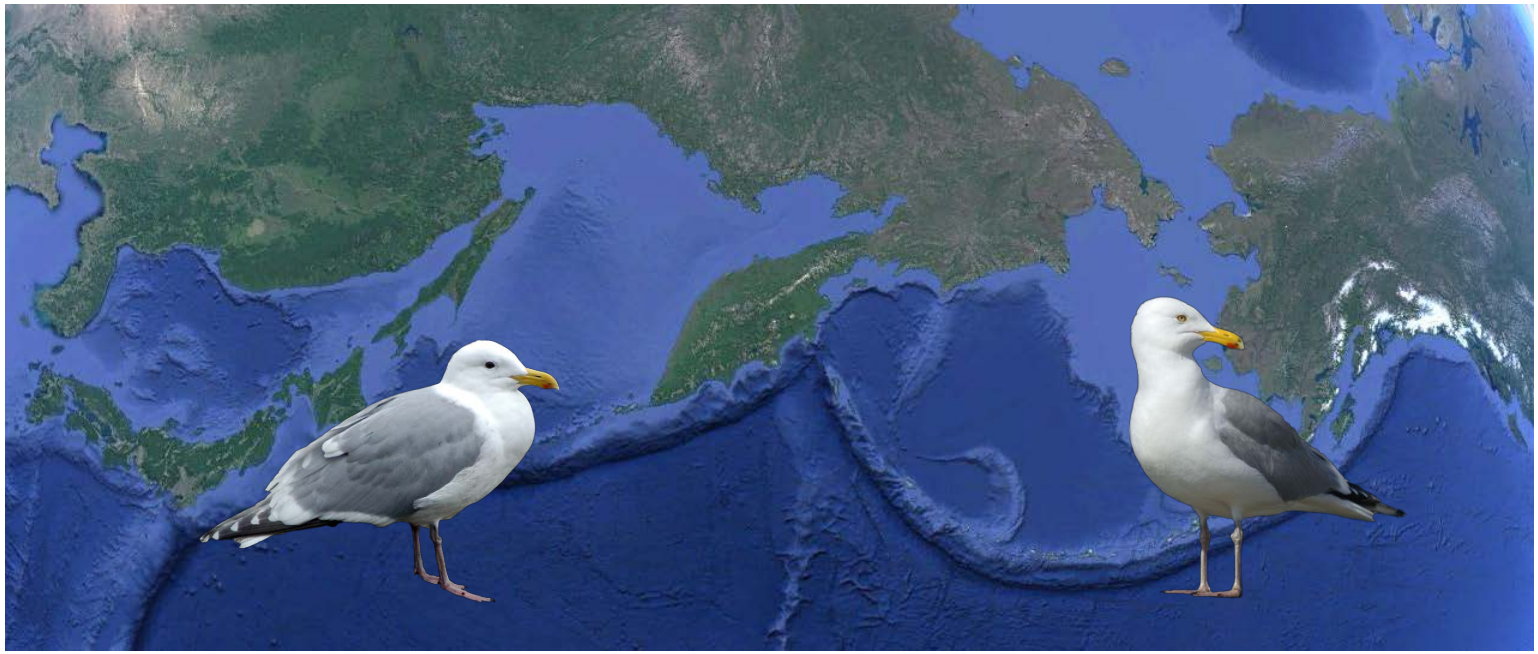
Ongoing/future work:

Intercontinental scale – research questions

1. Do large gulls make migratory movements between East Asia and Alaska that could facilitate inter-hemispheric dispersal of ABR *E. coli* and other infectious agents?
2. Is there genetic evidence for inter-hemispheric dispersal of ABR *E. coli* in large gull populations sampled in Alaska and East Asia?



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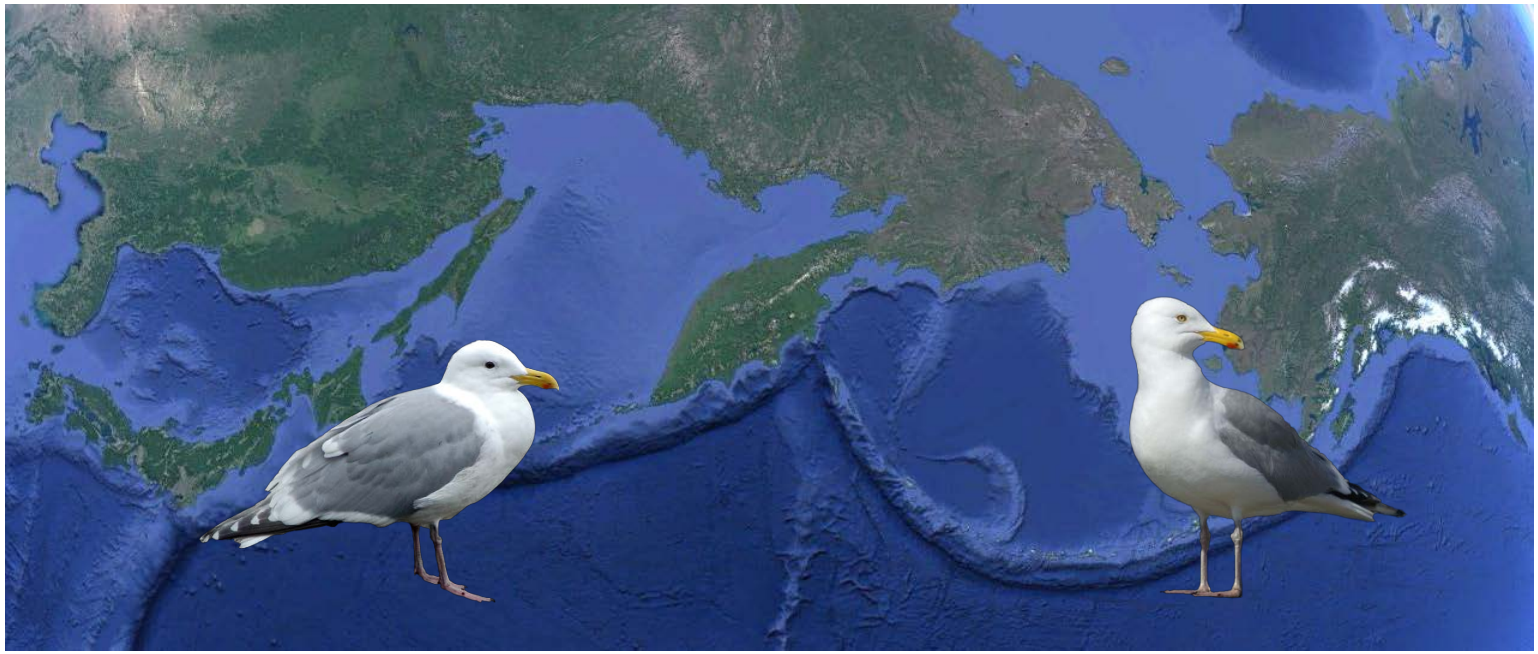
Ongoing/future work:

Intercontinental scale – research activities

- Sample gull feces at locations in Japan and South Korea in June and August of 2017
- Phenotypically/genetically characterize resultant *E. coli* isolates
- Apply satellite transmitters to large gulls at locations throughout Alaska



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Questions?