Green Security

How Can AI Help in Protecting Forests, Fish and Wildlife

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WHAT MIGHT WE LOSE?

Murchison Falls National Park, Uganda

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
Image IBCAO

Google earth

WHAT MIGHT WE LOSE?

Murchison Falls National Park, Uganda

PAWS: PROTECTION ASSISTANT for WILDLIFE SECURITY

Massive forests *(1000 sq miles)* **to protect, limited security resources:**

- How to Efficiently Patrol/Protect forests with limited resources

- PAWS patrols: Exploit past poaching data, avoid predictability

Patrol boat in Bangladesh
at Global Tiger Conference, 2014

Patrol with Rangers, Indonesia
Trip with WWF, 2015

AI-based DECISION AIDS TO ASSIST IN SECURITY

Game Theory

Airports

2007

AI-based DECISION AIDS TO ASSIST IN SECURITY

AI-based DECISION AIDS TO ASSIST IN SECURITY

Airports

2007

Player B

Player A

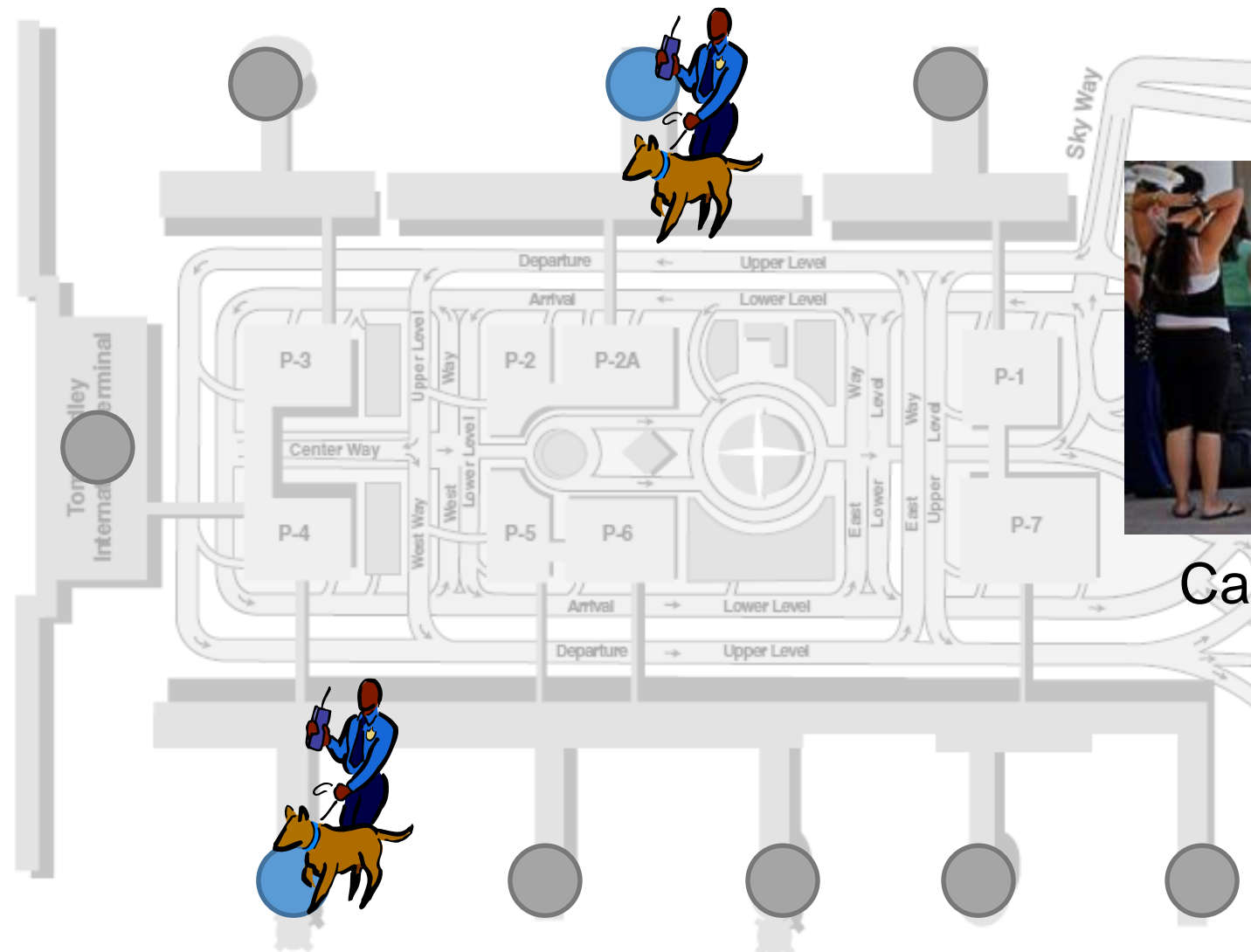|	Paper	Rock	Scissors
Paper	0, 0	1,-1	-1,1
Rock	-1, 1	0, 0	1, -1
Scissors	1, -1	-1, 1	0, 0

AI-based DECISION AIDS TO ASSIST IN SECURITY

Game Theory

Airports

2007

Canine patrol at LAX (*ARMOR*)

AI-based DECISION AIDS TO ASSIST IN SECURITY

Game Theory

Airports

Air Marshals

Ports

2007

2009

2011

PROTECT: FERRY PROTECTION DEPLOYED [2013-]

AI-based DECISION AIDS TO ASSIST IN SECURITY

Game Theory

Airports   **Air Marshals**   **Ports**   **Trains**

2007   2009   2011   2013

GLOBAL PRESENCE OF SECURITY USING GAME THEORY

MILIND TAMBE'S ARMOR AND ITS MANY ITERATIONS ARE USED AROUND THE WORLD TO PROTECT AGAINST TERRORISM, POACHERS, ILLEGAL FISHING AND OTHER THREATS.

DEPLOYED

Ports — PROTECT
PROTECT intelligently randomizes U.S. Coast Guard patrols to optimize scarce resources to secure crowded piers, bridges and ferry terminals.
PROTECT is employed at:
Port of New York and New Jersey
Port of Boston
Port of Houston
Port of Los Angeles-Long Beach

Staten Island Ferry — PROTECT
PROTECT provides protection to the Staten Island Ferry, which carries up to 4,000 passengers at peak times.

Los Angeles International Airport — ARMOR
ARMOR intelligently randomizes schedules of checkpoints along the five roads that lead into the airport.

U.S. Air Traffic — IRIS
As part of its multipronged strategy to prevent attacks, the Transportation Security Administration (TSA) has since 2009 deployed Milind Tambe's IRIS system, which intelligently randomizes federal air marshals' flight schedules to make their air patrols unpredictable to would-be malefactors.

SUCCESSFULLY TESTED

Gulf of Mexico (Near Corpus Christi, Texas) — ARMOR-FISH
ARMOR-FISH intelligently randomized schedules for U.S. Coast Guard aerial patrols to thwart the illegal fishing of decimated shark and red snapper populations. (2014)

Los Angeles Metro — TRUSTS
The Los Angeles Sheriff's Department, which LA Metro subcontracts for security, employed TRUSTS to intelligently randomize patrol schedules to stop fare evasion. The Sheriff's Department later ran preliminary experiments to ascertain effectiveness in deploying scarce police personnel to deter crime and terrorism on LA Metro. (2011-2013)

Uganda — PAWS
Ugandan rangers tested PAWS at Queen Elizabeth National Park to intelligently randomize patrols to prevent the slaughter of animals, including Cape buffalo, waterbuck and giant forest hogs, which are served up locally and exported as "bush meat." (2014)

Malaysia — PAWS
Panthera, an NGO that is committed to ensuring the survival of tigers and other wild cats, in conjunction with the nonprofit group Rimba, began testing PAWS in forests in northeastern Malaysia, to evaluate its ability to generate effective patrols in the challenging, hilly terrain. (2014)

POSSIBLE FUTURE TEST SITES

Vietnam, Cambodia, Bangladesh, Indonesia — PAWS

FUTURE TEST SITES

Singapore — STREETS
Singaporean traffic authorities could employ STREETS to intelligently randomize police patrols to catch reckless drivers, a big problem in this island nation.

Madagascar — PAWS
Milind Tambe, working with Meredith Gore, an associate professor of conservation social sciences at Michigan State University,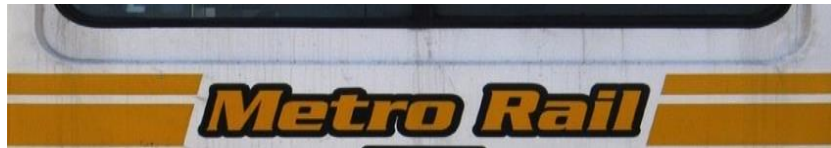 and a Malagasy civil society group called Alliance Voahary Gasy (AVG), hopes to eventually employ PAWS in Madagascar to randomize patrol schedules for rangers, police and national park officials to reduce environmental crimes, especially illegal logging.
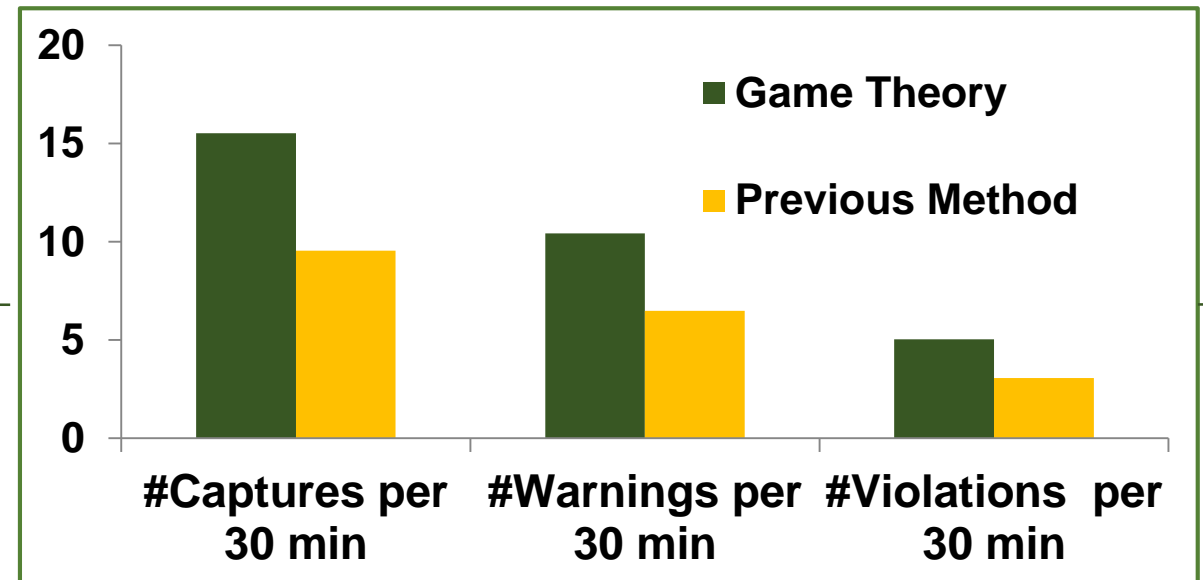
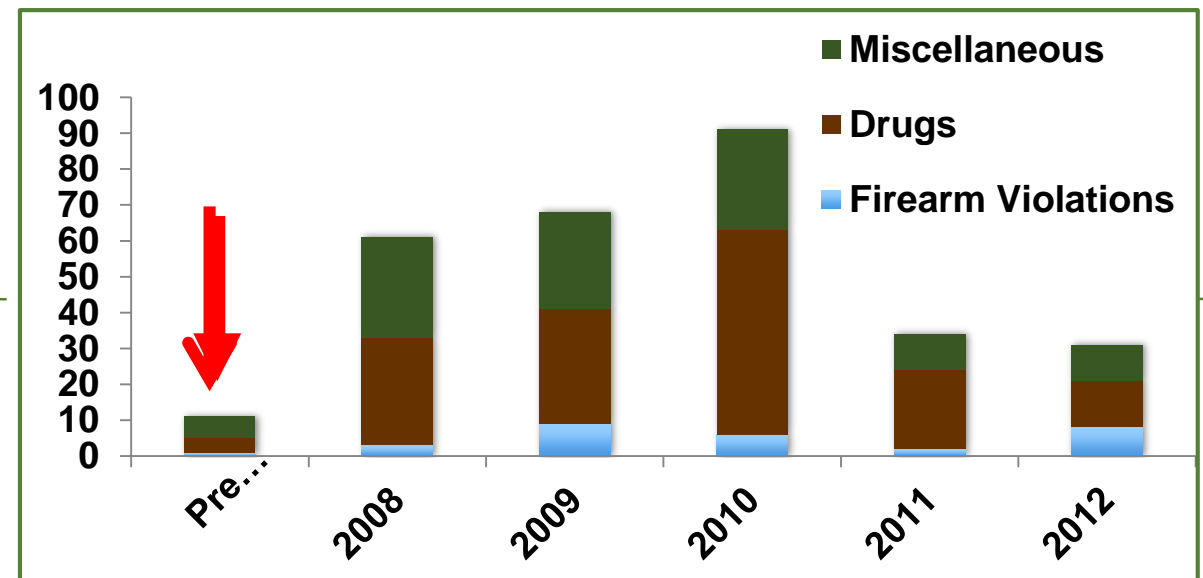# SOME RESULTS OF GAME THEORY for SECURITY

Game Theory in the Field

Ticketless Travelers Caught

- Game theory vs Previous Method

Arrests at LAX checkpoints

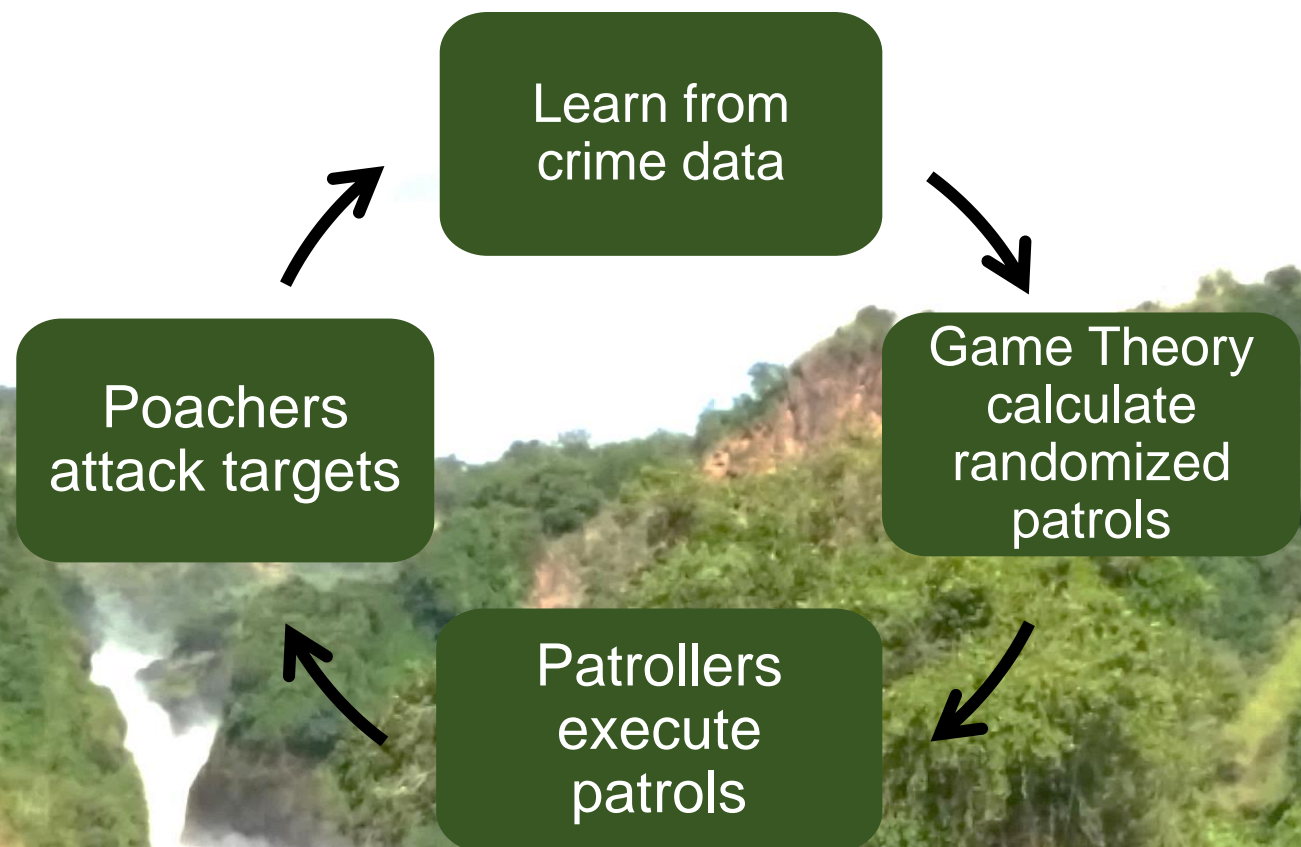# GAME THEORY FOR PATROLS [2013]

Congressional Subcommittee Hearing

PAWS: APPLYING AI FOR PROTECTING WILDLIFE
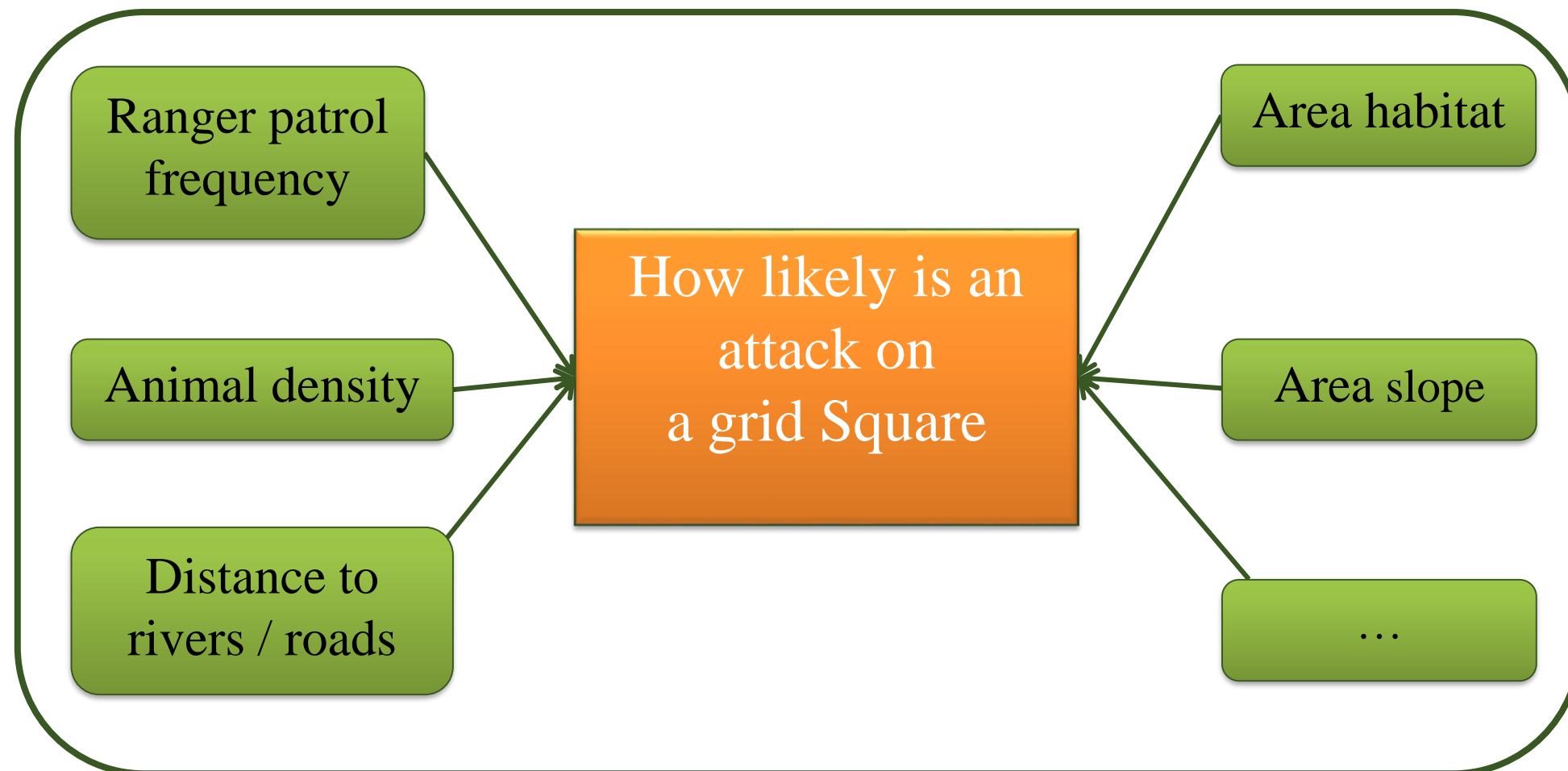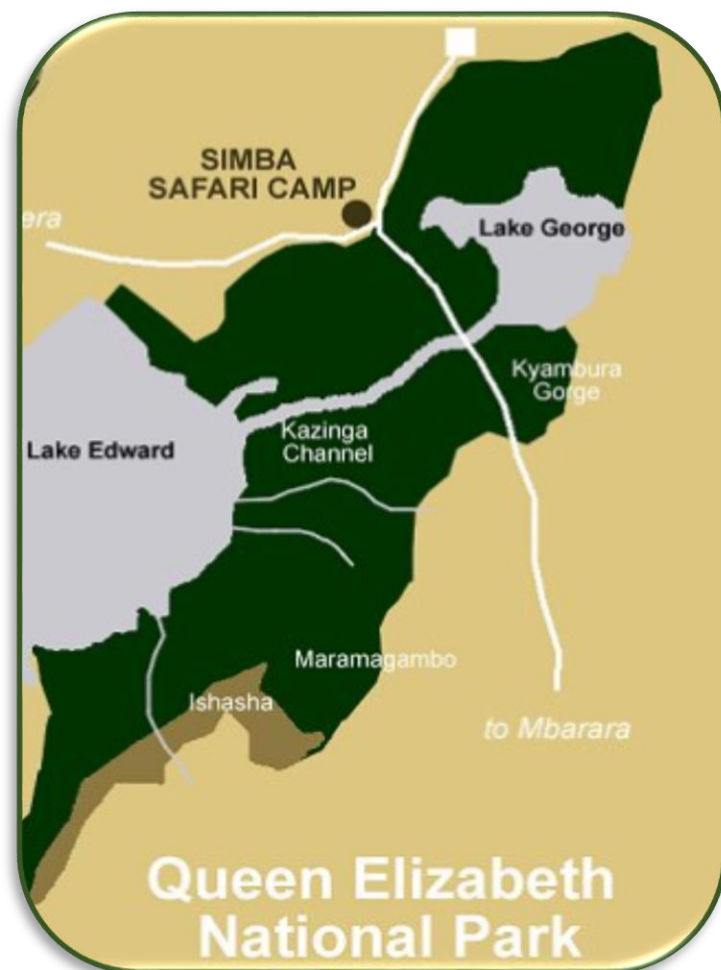
Game Theory + Poacher Behavior Prediction

Predicting Poaching from Past Crime Data

Learn from crime data

Game Theory calculate randomized patrols

Patrollers execute patrols

Poachers attack targets

POACHER BEHAVIOR PREDICTION

Queen Elizabeth National Park, Uganda
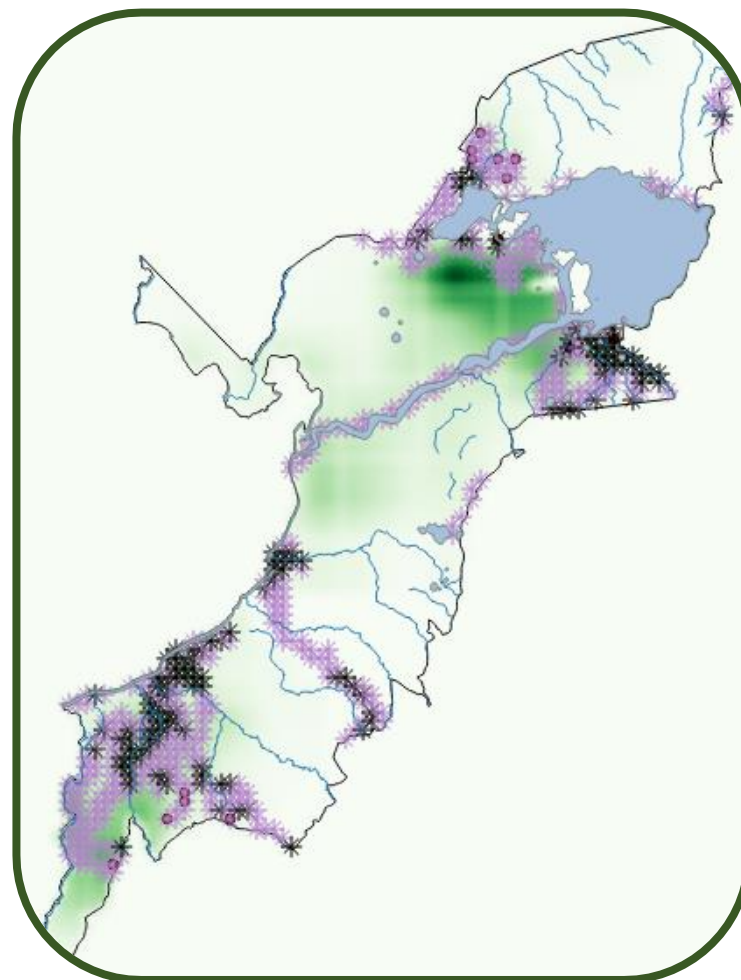
12 years of patrols, 125000 observations

Game Theory + Poacher Behavior Prediction

12 years of patrols, 125000 observations
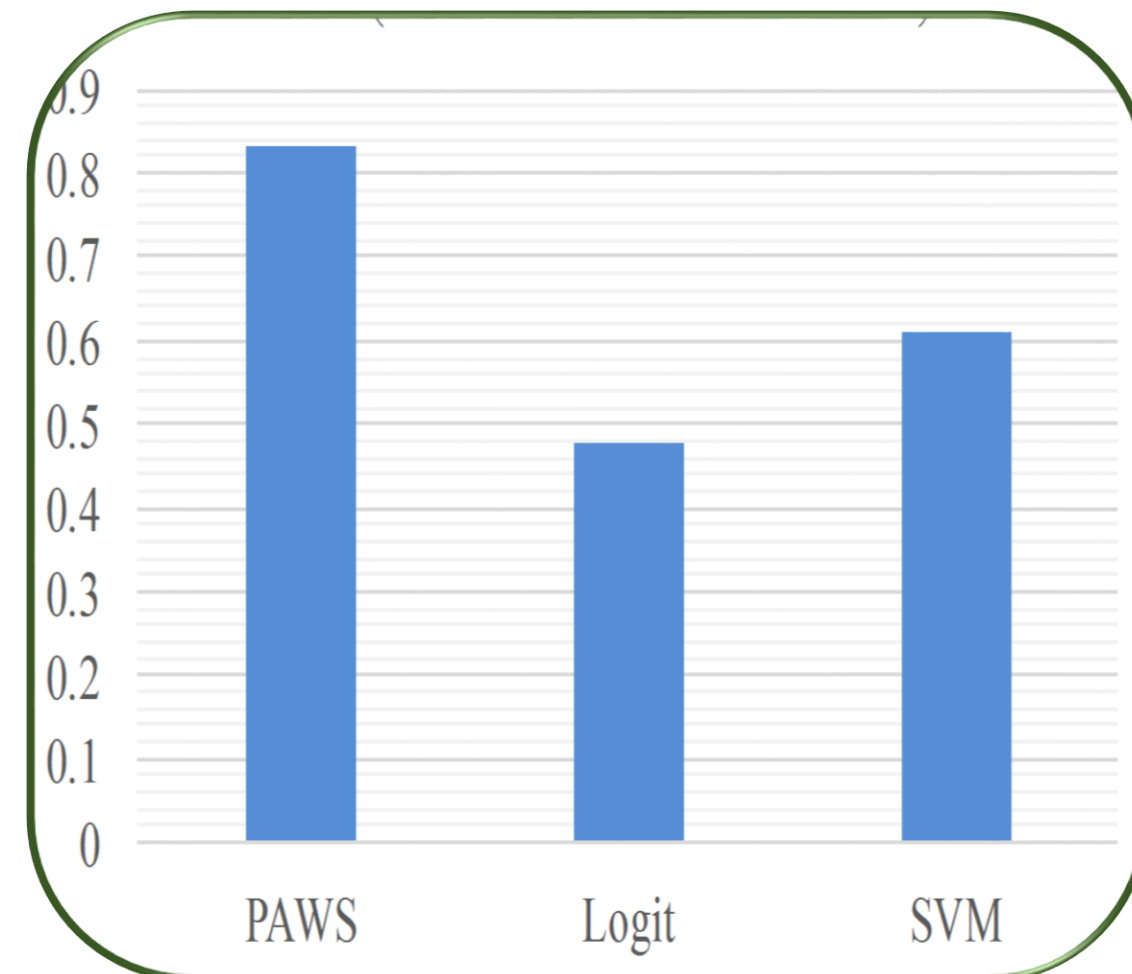
Dry Season (June-August 2008)

Trials in Uganda and Malaysia

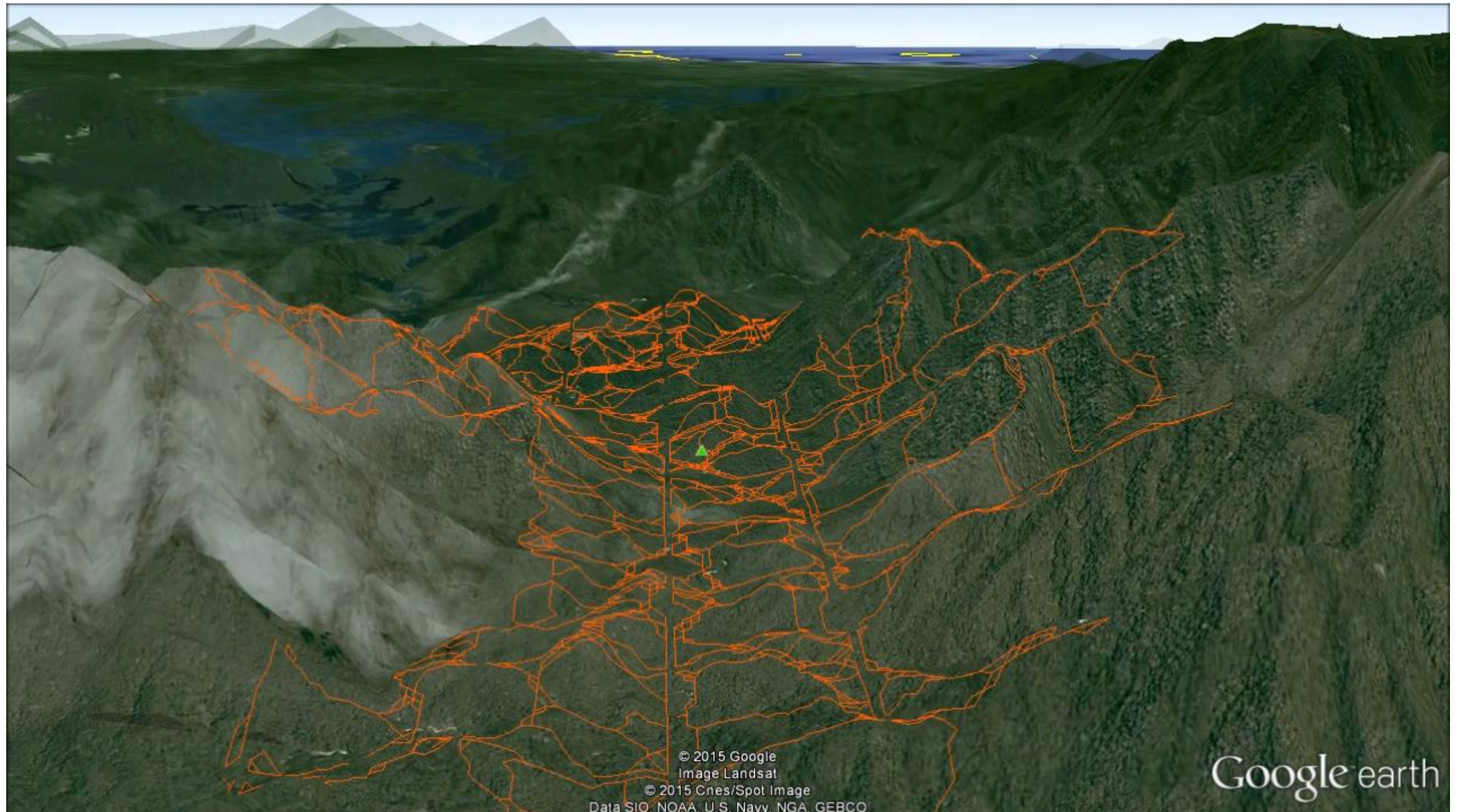### Important Lesson: Geography!

Uganda

Andrew Lemieux

Malaysia

Panthera

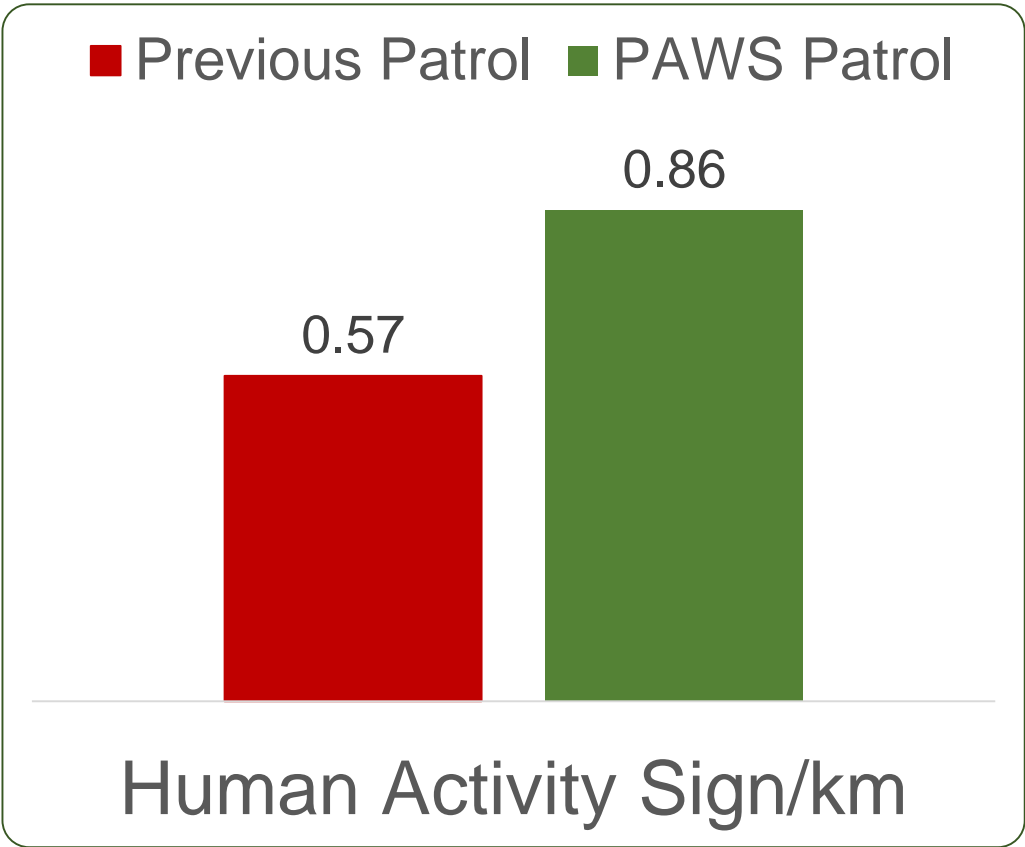# PAWS: PROTECTION ASSISTANT FOR WILDLIFE SECURITY [2016]

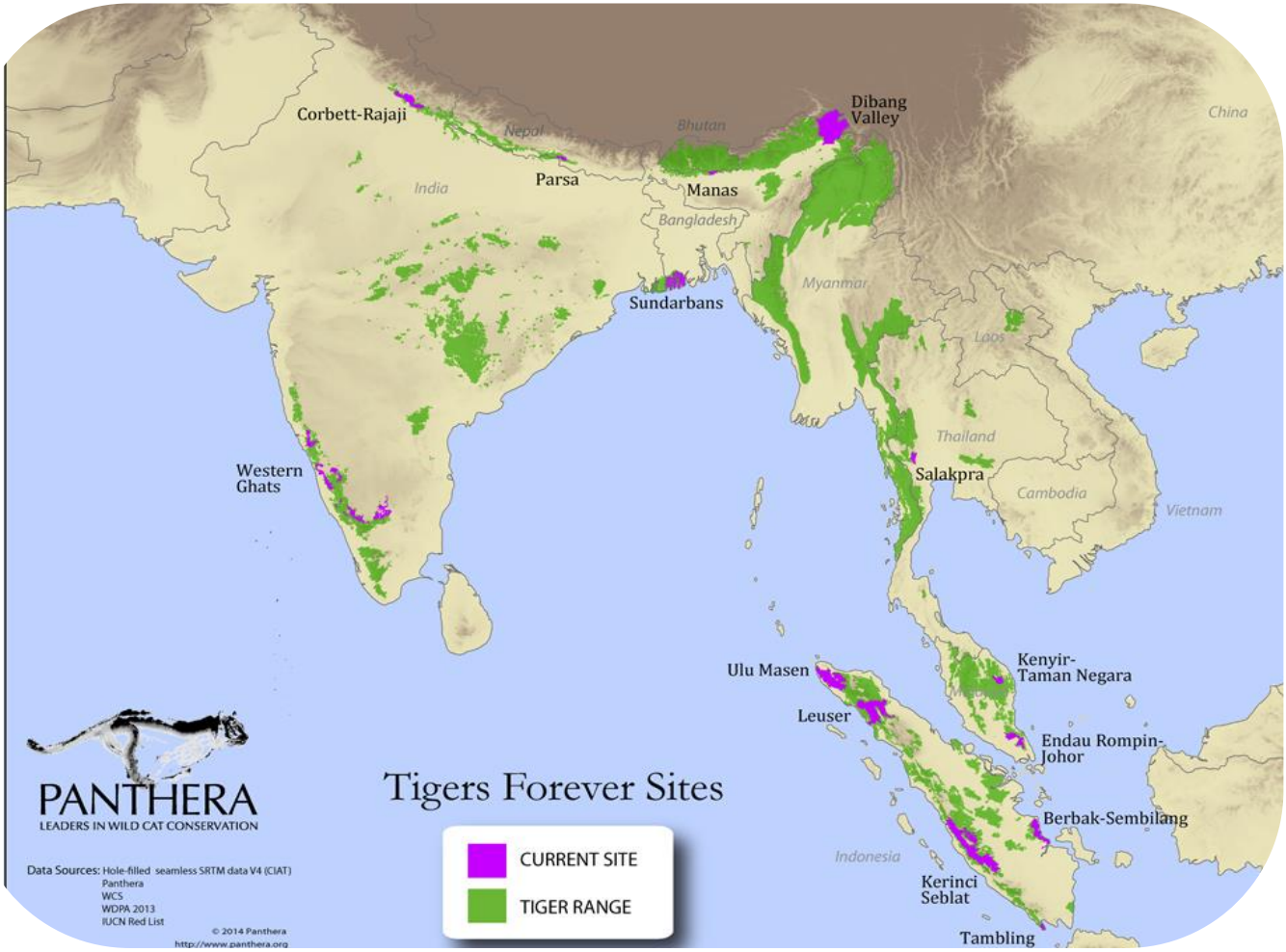Game Theory + Poacher Behavior Prediction + Forest Street Map

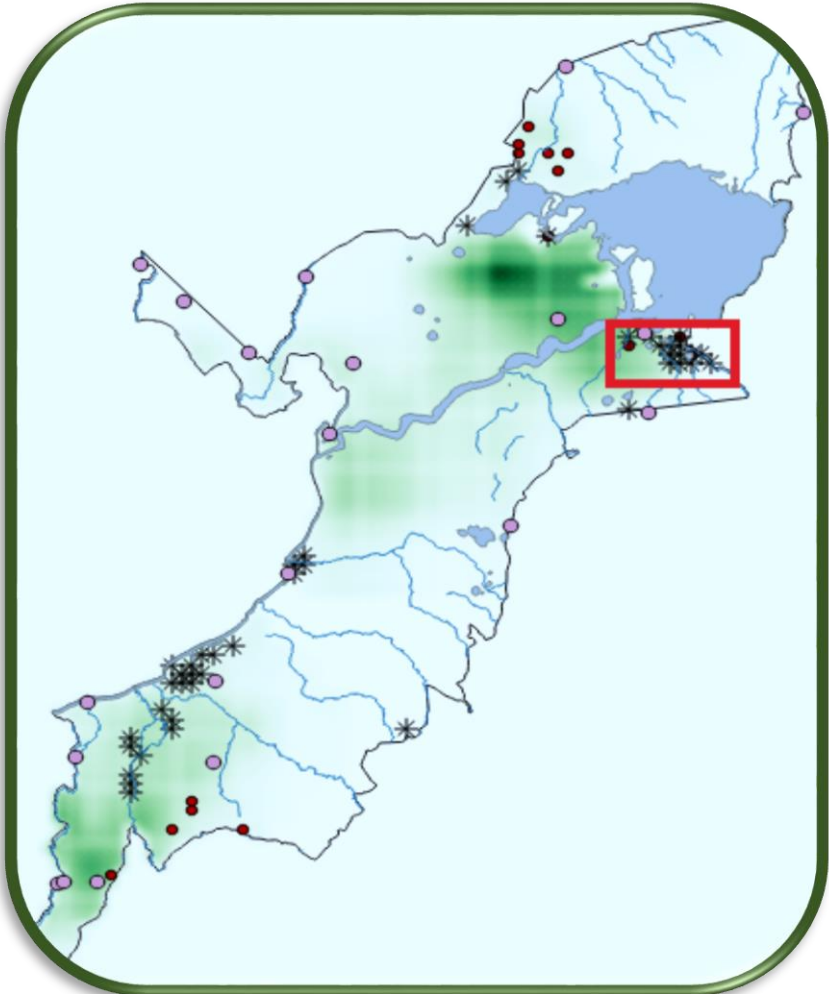# PAWS: PRELIMINARY EVALUATION

Human Activity Sign/km

- Previous Patrol: 0.57
- PAWS Patrol: 0.86

PAWS COLLABORATIONS

Protecting Forests, Fish, Rivers

FOREST PROTECTION

FISHERY PROTECTION

RIVER POLLUTION PREVENTION

AI and GAME THEORY WORLDWIDE FOR SOCIAL GOOD

Thank you to sponsors:

THANK YOU

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http://teamcore.usc.edu/security

EVALUATING DEPLOYED SECURITY SYSTEMS NOT EASY

How Well Optimized Use of Limited Security Resources?

Security Games superior
vs
Human Schedulers/"simple random"

| Lab Evaluation	Field Evaluation: Patrol quality Unpredictable? Cover?	Field Evaluation: Tests against adversaries
Simulated adversary	Compare real schedule	"Mock attackers"
Human subject adversaries	Scheduling competition	Capture rates of real adversaries
	Expert evaluation	

FIELD EVALUATION OF SCHEDULE QUALITY

Improved Patrol Unpredictability & Coverage for Less Effort

Patrols Before PROTECT: Boston
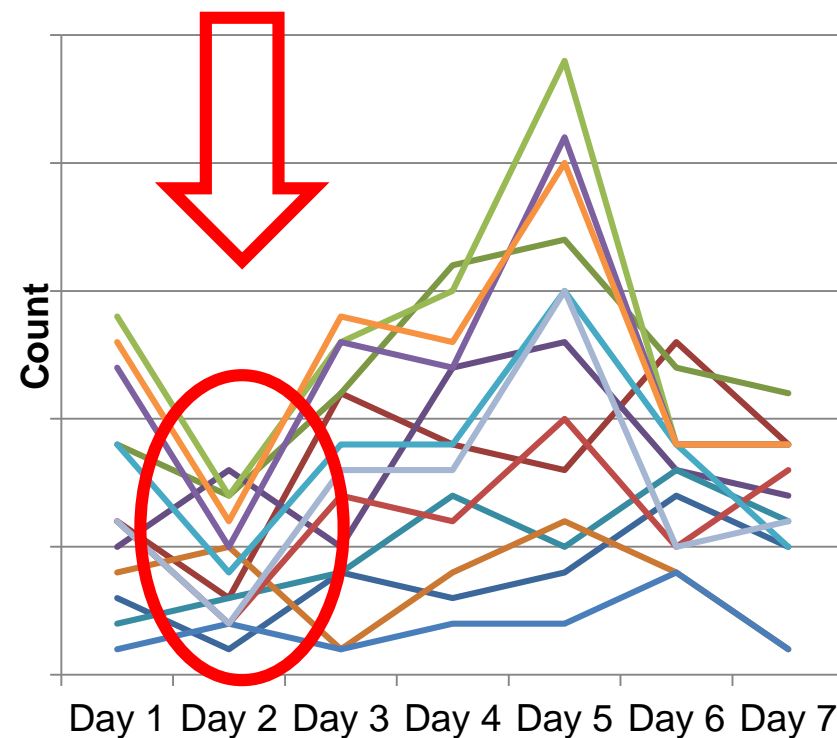
Patrols After PROTECT: Boston
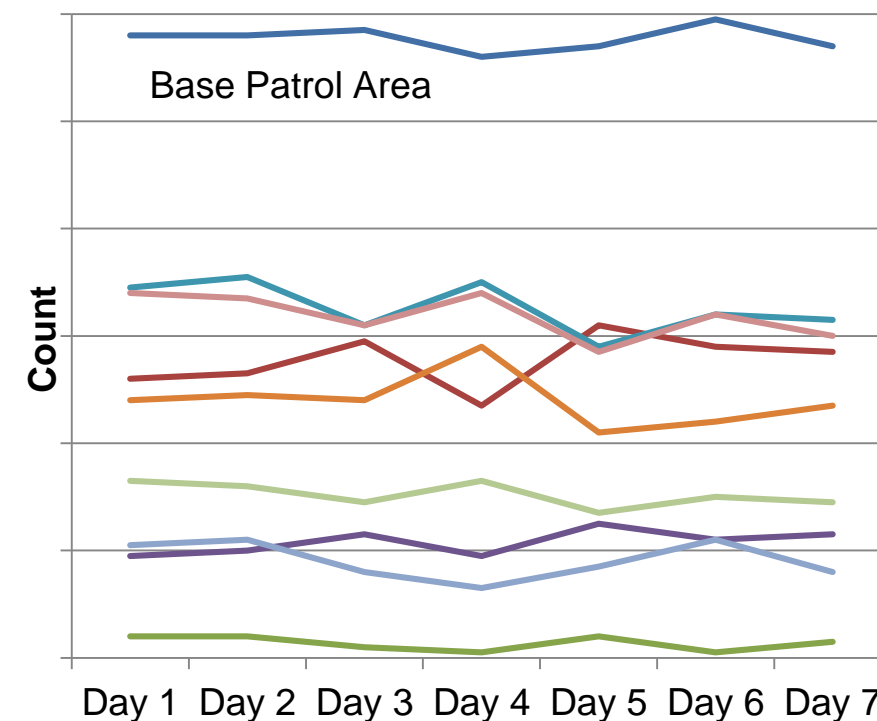
PROTECT (Coast Guard):   350% increase in defender expected utility
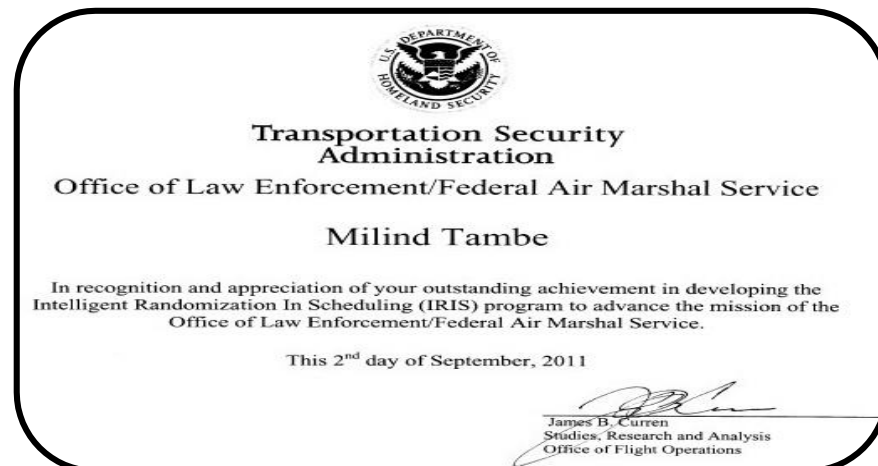
EXPERT EVALUATION

Example from ARMOR, IRIS AND PROTECT

June 2013: Meritorious Team Commendation from Commandant (US Coast Guard)

July 2011: Operational Excellence Award (US Coast Guard, Boston)

September 2011: Certificate of Appreciation (Federal Air Marshals)

February 2009: Commendations LAX Police (City of Los Angeles)