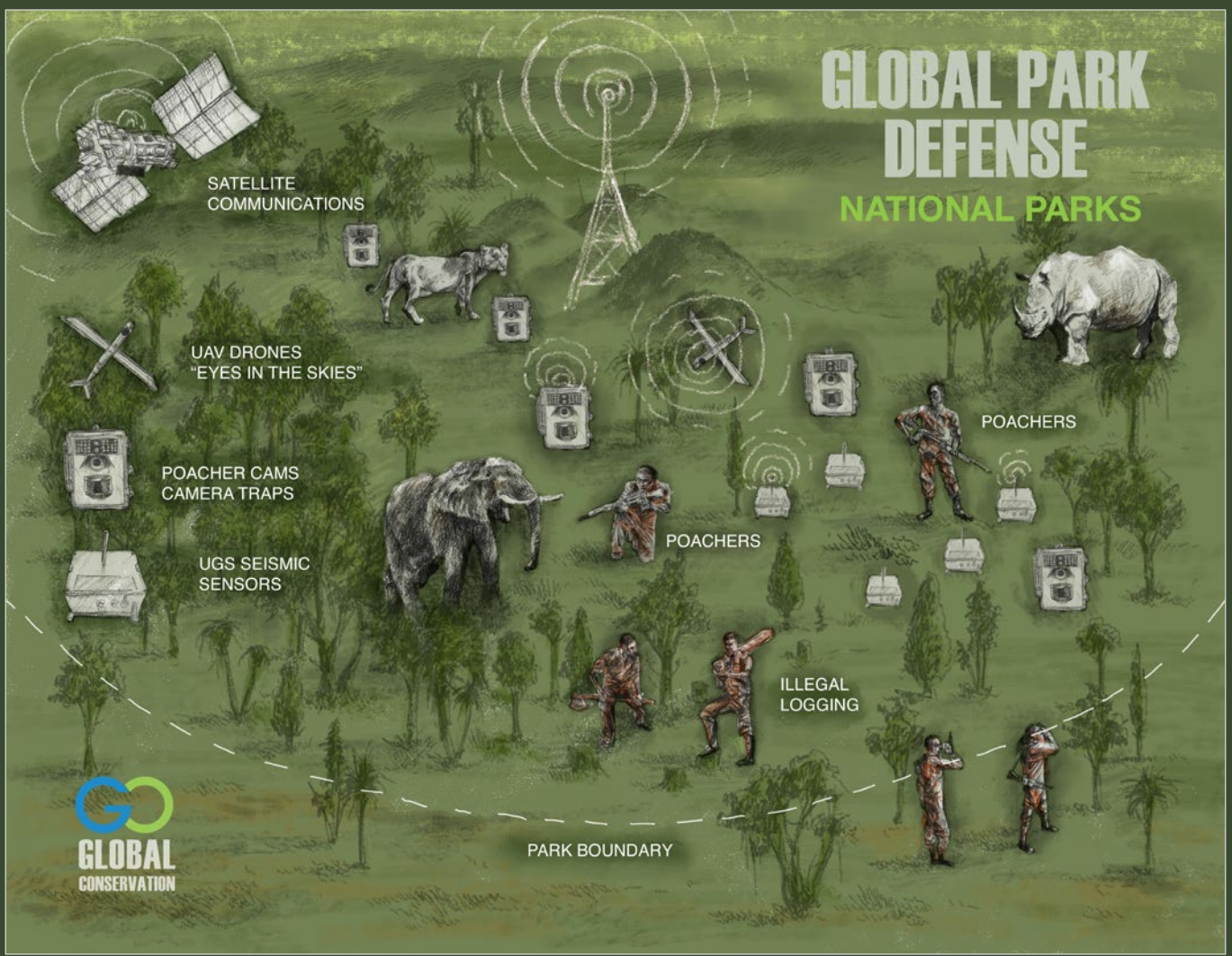
GLOBAL
PARK
DEFENSE

RANGER HANDBOOK

GO
GLOBAL
CONSERVATION



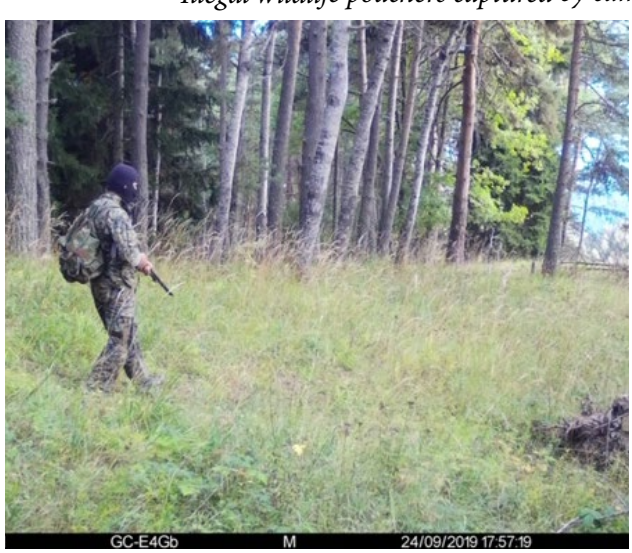
National Parks in developing countries are the last bastion for saving our major intact tropical forests and ecosystems critical for endangered species to survive.

- Jeff Morgan

TABLE OF CONTENTS:

Section Two: Components of Global Park Defense (cont.)

Illegal wildlife poachers captured by camera traps in Borjomi National Park, Georgia



Above: DaMaI Rainforest - Borneo

Below: Palau Northern Reefs

Section One

Introduction

In the past twenty years, we have lost over half of the world's intact tropical rainforests. Half of our wetlands and reefs have been destroyed, with most of the remaining reefs under immediate threat. For many countries, IUCN World Heritage Sites and national parks are the last bastions of protection for these vital habitats.

Illegal logging, land clearing, mining and wildlife poaching are decimating national parks, especially in developing countries where the resources to enforce conservation legislation are scarce. Without funding, many national parks in developing countries will be destroyed before they can be enjoyed by both domestic and international visitors.

Without protection, we will be losing not only the awe-inspiring beauty and biodiversity of national parks, but also the ecosystem services that they provide, like clean water, carbon storage, and clean air. That's why we are committed to Global Park Defense.

Illegal land clearing in the Leuser Ecosystem, Indonesia

CHAPTER ONE: GLOBAL PARK DEFENSE OVERVIEW

Using the power of UNESCO World Heritage and national park designation, Global Conservation assists national governments and park authorities to protect land and marine reserves using the best systems, technologies and training available.

Our program, called Global Park Defense (GPD), is a multi-year method to achieve "No Cut, No Kill" protection and financial sustainability for continued preservation.

Global Park Defense increases ranger patrol and park protection effectiveness in critical ecosystems. GPD is a scalable system with technology and training tailored to each park, dramatically increasing the effectiveness of rangers and park authorities to protect their world heritage.

Thap Lan National Park Rangers have been using Global Park Defense since 2015. Although effectively extinct, recent wild tiger sightings in the park indicate that our efforts are paying off.

Selection Criteria:

We are highly selective in choosing the projects that we support. In order for us to implement Global Park Defense, the site must meet the following criteria:

1. Be an endangered national park or UNESCO World Heritage Site in a developing country
2. Contain critical habitat for megafauna with intact, primary ecosystems
3. Must have potential for fundraising and collaboration with other NGO's
4. Have a park authority willing to commit to the Global Park Defense goal of "No Cut, No Kill", and be willing to fund park border demarcation and communications towers
5. Show excellent potential for sustainable tourism to support permanent protection

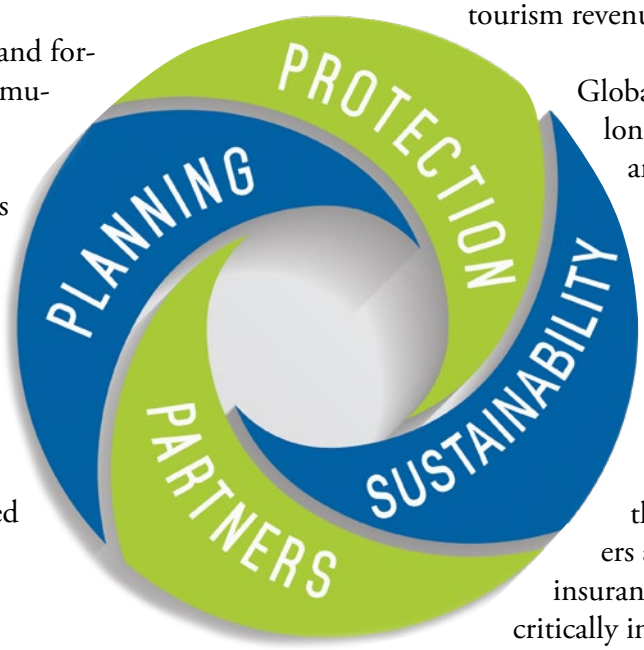
The Four Stages of Global Park Defense:

1. Planning: Threat assessment, security and surveillance design, ranger deployment strategy.

Before we can begin a Global Park Defense program, it is critical to have a thorough understanding of the threats. Our first step is to conduct a threat assessment as well as scientific baseline surveys of wildlife populations, which help us to track our progress. We then put together a detailed security and surveillance plan, as well as a strategy for ranger deployment.

2. Partnerships: Wildlife and forestry, government, telecommunications and co-funding.

Global Conservation brings critically important co-funders, government and private investment, and strategic partners to assist in conservation finance, park infrastructure and communications, scientific research and community-led tourism.



3. Protection: Community involvement, law enforcement and military support.

Armed with Global Park Defense, rangers are spotting and apprehending more wildlife and timber poachers in the world's most endangered parks. Under GPD, government rangers, community eco-guards, and sometimes military and police join forces on park protection. These collaborative teams use state-of-the-art tools, like Vulcan EarthRanger, SMART patrolling systems, and drones to intercept criminal activity and stop poaching and logging before it becomes severe.

4. Sustainability: Governmental budgeting, tourism revenues and park financing.

Global Conservation assists in securing long-term financing to fund park and wildlife protection after our multi-year Global Park Defense projects end. Each Global Park Defense deployment requires US$400-500,000 over 5 years for training, equipment and communications systems. Global Conservation requires national governments to increase the number of salaried park rangers and pay all salaries, benefits and insurance. Meanwhile, we bring together critically important co-funders, government and private investment, strategic partners, and carbon offset financing to assist in long-term conservation finance, park infrastructure and staff, communications, scientific research and community-led tourism.

Metrics for Measuring GPD Success:

Real Alerts/Real Intelligence:
We measure the number of alerts from the first day that cellular trail cameras are installed. If there are already existing camera traps, we note the number of alerts to date so that we have a baseline. In all cases, we check progress every six months to compare to the previous six months.

Kilometers Patrolled by Foot and Vehicle:
It is important to keep accurate records of kilometers patrolled for a few reasons. Firstly, since we aim to increase the number of patrols, we need a baseline. Secondly, it's also important to eliminate unnecessary patrol kilometers in areas without criminal activity. Finally, patrolling is also used to measure efficiency. If kilometers patrolled have decreased, but arrests and interdictions have increased, we know that we are patrolling more efficiently. We also want to differentiate and analyse the effectiveness of vehicle vs. foot patrols.

Number of Interdictions:
Interdictions need to be analysed to establish which of our methods are the most effective. We must keep track of the number of encounters when on patrol vs. interdictions that result from informant tips or camera alerts, etc. Overall interdiction numbers are then compared to the number of resulting arrests and convictions.

Number of Arrests/Confiscations:
Tracking the number of arrests and confiscations is important, because it gives us the percentage of interdictions/encounters that result in arrests for criminal activity. Confiscating guns, chainsaws, carcasses, drugs, or snares has an impact even without arrests. All confiscated items need to be documented and inventoried for possible future court cases and to monitor the extent of illegal activity.

Prosecutions/Convictions/Jail Time/Fines:
Stops and arrests will not have the intended impact if the legal system is failing. Convictions give us a measurement of government efficiency and corruption, and give us the opportunity to identify and change outdated laws and obstructions in the legal system. As an example, if many convictions result in small fines and minimal jail time, we know we need to reexamine the structure of the laws pertaining to wildlife protection.

Public/Media Communications:
The media plays a big role in reducing crime, especially when laws are weak. The media can expose criminals within and outside of the community and make people aware of the issues. It also flushes criminals out of hiding and puts added pressure on family, friends, the community and even other criminals to give information. Other criminals do not want media attention and scrutiny in an area where they may also commit crimes.

Wildlife and Forest Baseline Protection:
Tracking wildlife populations over time is an excellent way to assess progress, as well as to detect illegal activity. When we begin a GPD project, we start with a baseline wildlife population assessment. Then, we can compare all future assessments to that baseline to determine whether our conservation efforts are proving successful. If we detect a sudden change in a species' population, it may indicate increased poaching pressure, an increase in indirect impacts such as logging, or a landscape-scale change such as fire, pollution, or a natural disaster. Knock-on effects can happen, too -- a drop in predator numbers will often cause a rise in prey animal species. Once we detect such a change, we can start searching for the cause.

Example Budget - One Year of GPD Deployment:

Cellular Trail Camera Network: **$20,000**
- Spartan Trail Cameras
- Sim Cards
- Memory Cards
- 12 AA Batteries per Camera
- Mounting Hardware
- Locking Trail Camera Housings
- 4TB External Hard Drive

SMART Patrolling System: **$20,000**
- Command Center Equipment
- Smartphones / Cell Phones
- Laptops / Desktop Computer
- 4TB External Hard Drive
- Software Installation / Maintenance
- Reliable Internet

Park-Wide Satellite Communications: **$15,000**
- Spartan Trail Cameras
- Sim Cards
- Memory Cards
- 12 AA Batteries Per Camera

Ranger Training: **$15,000**
- Mapping Software
- Patrol Tactics
- Firearm Safety (where applicable)
- UAVs (drones)
- First Aid
- Investigation Support

Patrol Operations: **$30,000**
- Fuel and Oil
- Repairs and Maintenance
- Food and Water for Patrols
- Driver, Pilot, Boat Captain Fees

Ranger Equipment: **$20,000**
- Backpacks
- Boots
- Camping Equipment
- First Aid Equipment
- Relevant Tools
- Vehicles

Example Budget - One Year of GPD Deployment: (cont.)

Reserve Expenses: **$10,000**
- Emergency Response Funds
- Equipment Loss
- Government and Legal Fees

Project Leadership: **$20,000**
- Global Conservation Team Oversight
- Travel Costs
- Meetings
- Training Staff
- Salaries

TOTAL BUDGET - ONE YEAR OF GPD **$150,000**


TRAIL
ENTRANCE

Quick Tips for Kick-Starting a Global Park Defense Program:

1. Be Thorough:
Do not initiate your GPD plan without doing your own investigation of known and potential threats in the area first. Be thorough in your initial threat analysis; oftentimes, problems on the ground are a product of a greater root issue that needs to be addressed.

2. Paving the Way:
Communication is the most important factor in rolling out a GPD plan. All relevant governmental and non-governmental parties must be on board before moving forward, otherwise unforeseen issues will likely arise.

3. Leadership:
Assign responsibility for the following:
A. Lead Ranger for the Field
B. Camera Team responsible for relocating cams
C. Communication Center Manager
D. Mapping and GPS
E. Project Manager

4. Minimizing Risk:
Only a select group of personnel should know and have access to camera locations. This cuts down on possible corruption, and narrows the investigative field should you have to perform an internal investigation.

5. Data Security:
The Command Center is off-limits except for vetted personnel involved directly in the program launch.

6. Data Collection is Key:
GPS units are to remain on at all times in the field to leave a digital footprint and record of all incidents and distance traveled.

7. Surveillance:
Camera traps can be set at ground or treetop level, either hidden or purposely visible as a deterrent.

8. Common Sense Approach:
Camera traps should be placed in strategic locations. Chokepoints, water sources, ridgelines, trail convergences, and of course sites of previous illegal activity are all good places to start when selecting camera locations.

9. Covering Your Bases:
Cameras should always be placed in groups of no less than two. Each camera should be within the field of view of another camera. Typically, 4 to 5 cameras will be placed in a selected area to cover alternate routes, all possible navigable directions, and other cameras.

10. Stay One Step Ahead:
Cameras themselves can be used as bait to catch thieves, vandals, and criminals. Set up a poorly hidden camera in a location that can be monitored by surrounding hidden cameras to catch people tampering.

Quick Tips for Kick-Starting a Global Park Defense Program: (cont.)

11. Community Involvement:
The local community is usually your best source of information, so start to build a relationship with locals and make it beneficial for them to share information with you.

12. Laying the Groundwork:
Patrolling data must be logged in a timely fashion in order to draw an accurate map of problem areas vs. areas that may demand less attention.

13. Work SMARTer:
After year one, all patrolling should be based on the data entered into the SMART system in order to minimize wasted man hours and maximize manpower.

Quick Tips for Kick-Starting a Global Park Defense Program: (cont.)

14. Strength in Numbers:
Rangers should patrol in groups of at least four when possible but never less than three.

15. Chain of Command:
Always establish a point man or woman before any patrol or spontaneous interdiction. This could be the longest-tenured ranger, by rank, or simply by rotating schedule, but must always be established before patrolling.

16. Communication and Mobility:
Patrols should be done in a single staggered (left to right) line but can be single file at times.

17. Maintaining Discipline:
Always cover the side you are staggered to. The point man looks forward, while the second man is staggered left and therefore covering the left. The third man is staggered to the right, covering the right, and the last man covers the back regardless of the side he is staggered to.

Quick Tips for Kick-Starting a Global Park Defense Program: (cont.)

18. Maximize Your Opportunity for Success:
Patrols should be done as quietly as possible and hand signals should be used whenever possible.

19. Failing to Plan is Planning to Fail:
When responding to an alert, identify all possible escape routes in that corridor and block them off so that the reaction team can move in.

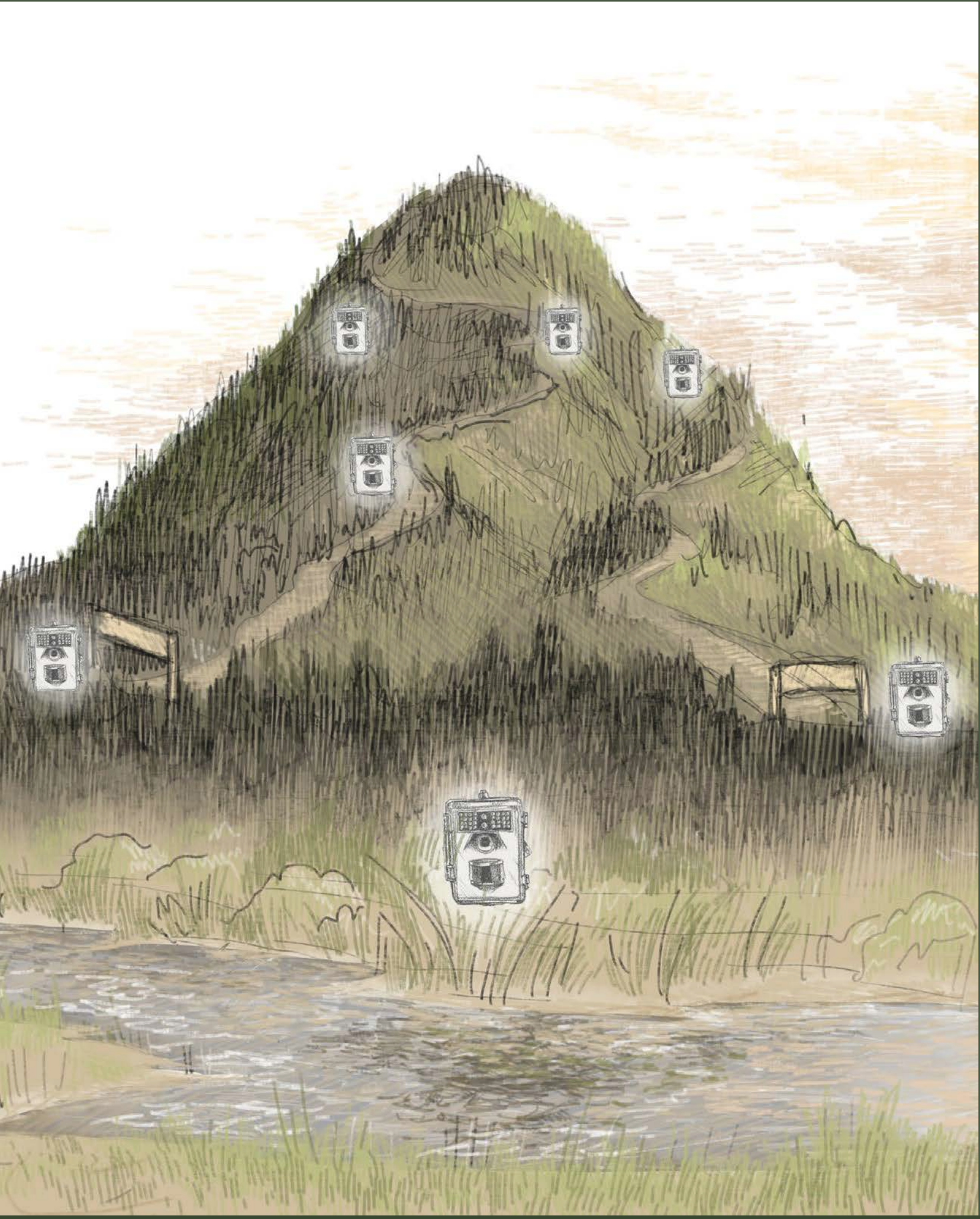
20. Safety First:
When multiple units are responding, all units must know the location and direction of approach of all other units. If rangers deviate from said route, the command center and other units on-site must be immediately notified to avoid friendly fire.

21. Growing Your Database:
When making contact with suspected or potential criminals, gather as much information as possible to be entered into the database. This includes name, address, date of birth, and photos whenever possible.

Global Park Defense is helping rangers make more arrests and stop illegal activities inside their parks.

AVOIDING FRIENDLY FIRE INCIDENTS:

- Know the locations of other rangers on the ground
- Keep commmand and team notified of your movements
- Maintain steady communication with other units



CHAPTER TWO: GPD PLAN OF ACTION

With Global Park Defense, the park authority and ranger teams will have increased capacity and improved effectiveness to escalate park and wildlife protection, law enforcement, and biodiversity monitoring. Our goal is to achieve "No Cut, No Kill" protection for each park/World Heritage Site within 5-6 years.

Global Park Defense is a scalable system with technology and training tailored to each park, dramatically increasing the effectiveness of rangers and park authorities to protect their world heritage. We use technology to fill the void created by lack of personnel and resources.

Working directly with park authorities, local communities, park ranger teams, law enforcement, and the military, we deploy an integrated program that involves Threat Assessment, a Solutions and Protection Plan, System Deployment, Annual Evaluation of Progress, and finally an Exit Strategy.

Global Park Defense brings Silicon Valley technology to developing countries.

CHAPTER TWO: GLOBAL PARK DEFENSE PLAN OF ACTION (cont.)

1. Threat Assessment:
Global Conservation begins with a detailed Threat Assessment. We work with leading experts to identify the most threatened wildlife and core habitats. This assessment combines local knowledge and community inputs with data gathered from cellular trailcams, satellites, drones and advanced mapping.

2. Solutions and Protection Plan:
Every national park or protected area will have problems unique to its flora and fauna. Protecting ecosystems on two different continents will likely call for greatly different approaches. Although equipment and general technique will be the same, the approach and implementation will vary. We create a plan that most benefits that area and gives us the best opportunity to achieve our goals for protection, conservation, and sustainability. See Appendix A for an example of a 4-year budget and protection plan.

3. System Deployment:
It is important that all rangers, tech support personnel, and management are trained on equipment before it is deployed. Areas of interest need to be identified and recorded to determine locations for surveillance equipment, patrol and maintenance routes, and nearby trails.

4. Annual Evaluation of Progress:
In order to measure the success of our Global Park Defense system, we must establish a baseline. We first determine what the statistics are for the area we are targeting during the "Threat Assessment" phase. We then do an initial evaluation at six months and a yearly review to track progress. We analyze relevant photos, interdictions, arrests, and prosecutions. Proper adjustments in strategy will then be made based on the data collected during the evaluation and review phase.

5. Exit Strategy:
Sustainability is a major factor when selecting a project. It is important that we develop a plan to ensure sustainability once we complete a successful Global Park Defense set-up and implementation project. The Global Park Defense strategy is a low-cost, highly effective program if deployed correctly and can be sustainable, even in underfunded parks, with proper planning. This often involves leaving a revenue stream and funding structure in place to support the project upon our exit.

We use satellite imagery as part of the pre-deployment threat assessment process for Global Park Defense.

Components of Global Park Defense

Achieving actual protection over millions of hectares faced with threats like illegal logging and wildlife poaching is never easy, and requires continuous efforts on five fronts: Surveillance, Patrolling and Communications, Community, Prosecution, and Sustainability.

CHAPTER THREE: SURVEILLANCE

Less than 1% of criminals are caught in the act of a crime. Monitoring remote and high-crime areas provides valuable information for investigations. Much as CCTV cameras protect cities, airports and shopping malls, Global Park Defense monitors all roads, trails and rivers known for illegal activities. By providing real-time alerts about illegal intruders, rangers can rapidly respond and make arrests. Key tools include:

Cellular Trail Cameras,based on low-cost consumer technologies, use satellite, cellular or radio connections to send real-time surveillance photos of wildlife and illegal trespassers from around the park to ranger patrols. These transmissions include location, heading, and facial images for later prosecution.

Cellular trailcams are deployed at strategic locations on roads, trails and rivers to provide real-time surveillance of all illegal activities, allowing rapid targeting for ranger interdictions. Cameras can be put in plain view or hidden, but they should always be set in areas of interest. For example, game trails, ridges and waterways are always important, as they are used by poachers, miners and loggers frequently.

Choke points (where multiple trailheads meet) and water crossings are also important locations for both wildlife and illegal human activities. A key component of Global Park Defense, Global Conservation has deployed hundreds of cellular trailcams in parks around the world. They can be placed in remote areas to determine if patrols are needed, and rotated to various locations or set up as a permanent network.

The real-time surveillance allowed by cellular trailcams is a critically important technological tool for Global Park Defense, but it must be paired with rapid response to alerts. If more than an hour passes, it can be difficult or impossible to intercept illegal activity without sniffer dogs or pro trackers to locate the criminals.

Trailcam networks are being used to create visual databases that enable rangers to identify criminals.

Virtual Fences can be made up of camera traps, motion sensors, alarms, thermal technology or vibration detectors. We typically use camera traps and/or ultrawave sensors, which send out a microwave beam that triggers an alarm when the beam is broken.

In Mana Pools National Park, Zimbabwe, we are in the process of setting up two virtual fences. The majority of poachers in Mana enter by crossing the river, which is also the border with Zambia. A fair number of poachers also attempt to enter via the southern boundary of the park, especially as patrols increase on the river.

Consequently, we will deploy 20 to 40 camera traps on said southern boundary. These motion-sensing, night-vision cameras will provide real-time alerts to the Akashinga Rangers, who are prepared for immediate interception.

On the river boundary we will also set 20 to 40 camera traps, but in addition we will deploy two Senstar ultrawave sensors. The Senstar units will detect motion and send alerts to the cameras, which will in turn alert rangers in real time. Just two units will detect motion along 400 meters of riverbank at key entry points.

Thermal imaging scopes and cameras provide long-range surveillance across large land areas and marine protected areas from mobile observation posts. Thermal scopes and cameras can be of great benefit in dense foliage, large bodies of water, or any low- to no-light situation.

Thermal cameras read heat signatures, sensing the difference between ambient and body temperature. This produces a color-coded heat map, allowing for law enforcement to differentiate between animals and criminals in pitch-black lighting conditions and across large bodies of water.

More powerful thermal scopes can detect heat signatures up to two kilometers away. Thermal scopes and binoculars can be used at observation posts, on patrol, and during raids. They help rangers to differentiate targets in zero-light conditions in real time, much like the cameras. Rangers can spot potential danger before it is too late, greatly increasing safety.

Night vision works differently than thermal imaging. Where thermal imaging uses heat to detect animals, objects, and people in zero light, producing a simple heat map, night vision greatly amplifies existing light to create a clear image with a green tint. There must be a minimal amount of light present to effectively use night vision, but it provides a true image as opposed to just a heat signature.

Night vision works best in open expanses, where at least some moonlight is present. The benefit of a clear sight picture and much lower price point make them more common and numerous than thermal cameras and scopes. You might see an entire patrol equipped with night vision whereas you will not see more than a couple FLIR thermal imaging devices within one patrol unit.

Unmanned aerial vehicles (UAVs/drones) run aerial reconnaissance at a distance up to 40 kilometers, night and day, to identify illegal logging and poaching camps. Drones are an immense benefit for both mapping and for law enforcement. Although the noise they create makes them a poor option for tracking poachers, they can greatly increase safety by providing reconnaissance for law enforcement raids to prevent ambush.

They can also help managers to map critical data like deforestation and illegal camp locations. Drones are best used in open expanses rather than dense foliage, where maneuverability and visibility can be a challenge. Read more about drones on page 77.

Satellite imagery is critical for carbon monitoring. The planet has lost over 40% of our tropical forests over the past twenty years. That loss adds up to 342 million hectares – six times the size of Kenya, or five times the size of Texas. Experts estimate that the last remaining rainforests could be consumed in under 40 years.

Global Conservation's Carbon for Forests is the first forest-based carbon offset program which directly funds the protection and restoration of national parks. Read more about Carbon for Forests on page 70.

Satellite imagery analysis also provides daily updates on fires, forest clearing, illegal logging and mining camps, new road construction, and major changes to the park ecosystem so that patrol teams can be immediately alerted.

Global Conservation uses satellite monitoring to protect forests and biodiversity in the Americas, Asia and Africa. With GLAD deforestation alerts on Global Forest Watch, park authorities can

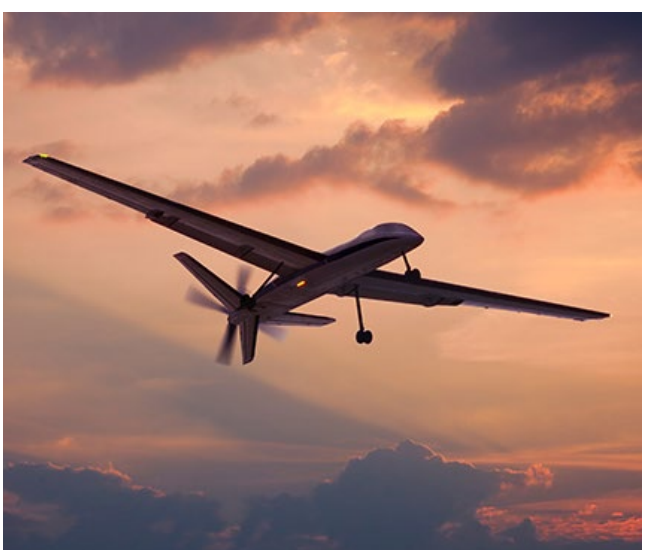
detect illegal gold mining and logging in protected areas within days. By getting timely and precise information into the hands of government authorities on the ground, they can take action within 24-48 hours of receiving an alert. Read more about Global Forest Watch on page 64.

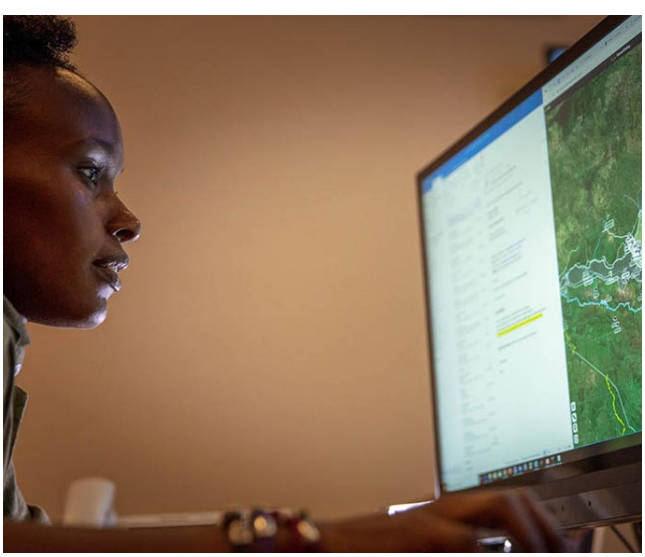
Global Information Systems (GIS), like ESRI ArcGIS, are instrumental for helping conservation managers to visualize data and understand patterns. GIS software helps managers gather environmental data into one place and to display it on a detailed map in combination with other data sets. For example, a manager could create a map that shows elephant movements derived from GPS collar data, and overlay it onto a map of environmental variables, like the location of water sources. EarthRanger (see below), takes this a step further, incorporating GIS data streams as well as criminal activity records, species counts, etc.

EarthRanger is a Vulcan Domain Awareness System (DAS), a software platform that collects information on activity in protected areas. This platform combines data from animal collars, SMART systems, trailcams, drones, satellite imagery, and other sources into a single, interactive digital map.

Together, the software is able to collect information about the animals being protected, the rangers protecting them, and potential threats, and integrate it into a real-time visualized operational platform. Managers can use this software to quickly analyze and proactively interdict illegal activity. It is also a very useful investigative tool and builds a database of criminals and criminal activity that can be referenced at any time.

EarthRanger is designed for those interested in security, human-wildlife conflict, and ecological monitoring in forest, savanna, jungle, or plains landscapes. Specifically, EarthRanger can be used by managers monitoring activity in protected areas, as well as governments interested in ranger activity, wildlife movement, and area perimeter integrity. Read more about EarthRanger on page 62.





VULCAN

CHAPTER FOUR: PATROLLING AND COMMUNICATIONS

Radios serve as a closed-loop communication system and are typically used in patrol vehicles, in boats, and by remote patrols. This allows them to remain in contact with their base, which can establish communication with the main command center when in remote areas. Radios allow rangers to call for help or backup and to communicate with other rangers and bases.

Cell phones and towers can be an incredibly useful tool for Global Park Defense. Working in a park or protected area that already has cell phone coverage is advantageous. However, more often than not, cell service is inconsistent, if it exists at all.

In the limited parks that do enjoy cell service, the rollout and deployment of our Global Park Defense Strategy happens much quicker than in parks without service. If cell service already exists, we can usually use the existing service for our real-time trail camera networks, SMART program, and communications. We can either cover the more remote areas that do not have reliable signal strength with satellite phones and GPS units, or install strategically-placed cell signal repeaters.

Signal repeaters can usually be installed at a fraction of the cost of a full cell tower. If there is no existing cell phone infrastructure in place, you must weigh the options of providing remote communication devices (e.g. satellite phones) across the entire expanse, or building one or two cell towers which can cost upwards of US$100,000 each.

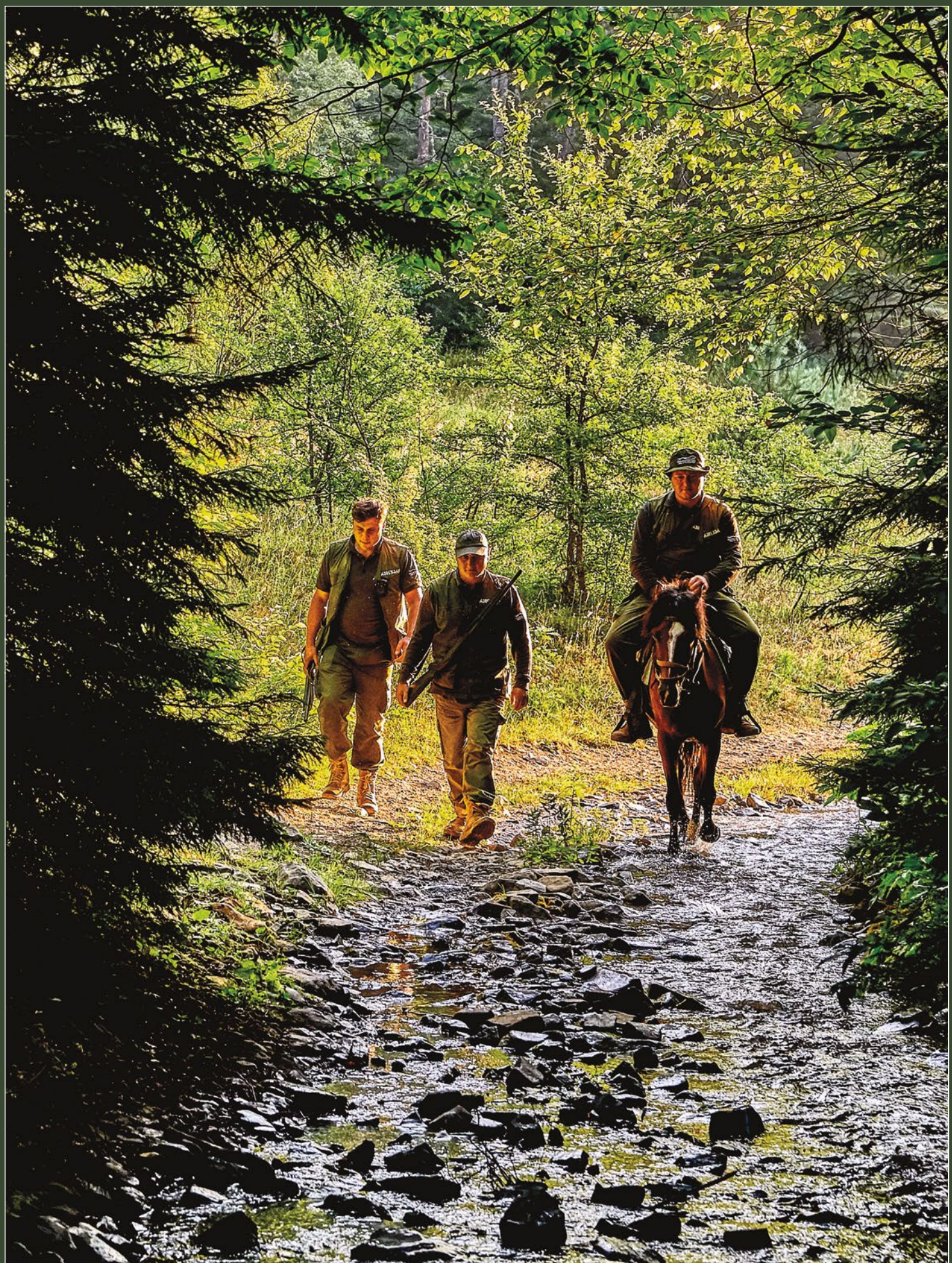
GPS communication devices are a key component of our Global Park Defense Strategy, especially where cell phone service is unreliable or nonexistent. They are used for navigation but can also send text messages via satellite to other GPS units, cell phones or an email address. Rangers can now relay information back to base or to other units in real time, making the chances of survival much greater when confronted with an emergency. Custom maps can be loaded on to the GPS units or made from data logged on the unit. Patrol routes, points of interest or incident sites can all be logged and compiled in a database. That data can then be analysed to determine areas with the most activity, allowing rangers to customize patrol routes accordingly.

Most parks are understaffed, but it is nonetheless critical to be able to cover large areas of interest. In most cases, focusing patrols and valuable resources in areas of need is the most efficient way to make up for lack of manpower. Coupled with the information gathered from strategically placed camera traps, we can use GPS logs to reduce wasted patrols in areas with no illegal activity.

Satellite phones and satellite internet devices can be used virtually anywhere on the planet, regardless of cell coverage or internet service. There are two basic types of satellite systems used for satellite communication: Low earth orbit satellites, or LEO satellites, and geostationary systems, or GEO satellites. LEO satellite systems consist of a number of satellites orbiting the earth to provide a coverage network over most of the planet.

These satellites are constantly moving across the sky. As a satellite phone communicates with the LEO satellites, they hand off the phone's signal from one satellite to another as each one orbits out of range. This means that the user needs to find a clear area, with no tree cover, and the signal can be inconsistent.

GEO satellites, on the other hand, orbit at a very high altitude. GEO satellites are almost 22,000 miles high, as opposed to LEO satellites, which



orbit at around 1,000 miles above the earth. GEO satellites are positioned over the equator at various points around the globe. Their orbital speed matches the rotation of the earth, so the satellite always appears at the same point in the sky.

Users may have to hike a bit to find a clearing with a signal, but once a signal is obtained it remains relatively consistent due to the fixed position of the satellites. This allows for longer phone calls, and also means that GEO systems tend to be better for satellite internet devices than LEO satellites. We utilize both systems for emergency communication, coordination, and cooperation. They are a lifeline where there is no other communication available, and greatly increase safety for our GPD teams on the ground.

Fortunately, satellite phones, satellite internet hot spots, and satellite sleeves for smartphones have become more affordable of late. This means for US$500-1200 you can provide communication for the most remote areas of a park. Rolling out a digital radio communication system can cost hundreds of thousands of dollars, but satellite devices can provide parkwide communications for a fraction of the cost. Unlike digital radio systems, satellite devices don't require a massive infrastructure investment up front, so we can get comms set up quickly and affordably.

Command and control systems give park authorities, ranger teams, and law enforcement a complete view of all threats, patrol movements, interdictions and arrests, location of cameras and sensors, and aerial surveillance. Command centers integrate all data feeds — video, radar and radio — into a single system for national park rangers to effectively deploy and communicate during interdiction missions. Further, locations of illegal activities and evidence collection for ticketing and prosecution of offenders is securely stored in a central database accessible by park rangers and enforcement staff.

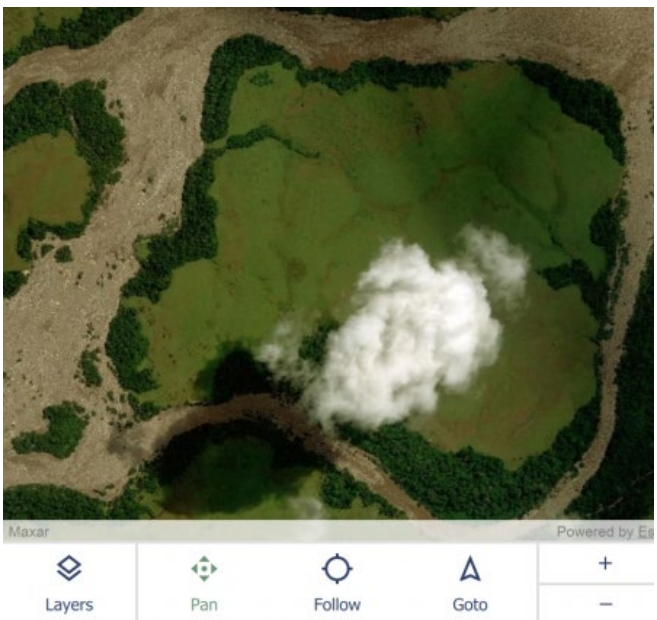
SMART patrols increase the efficiency of park surveillance and protection. The Spatial Monitoring and Reporting Tool (SMART) is a software tool that assists rangers and managers in reporting and managing data. The data can then be analyzed to improve adaptive management practices by compiling timely and accurate information on where, how, and by whom poaching, illegal logging and other direct threats to biodiversity are occurring.

SMART allows law enforcement teams to compile data from multiple sources, creating maps that are ideal for showing performance and patrol coverage, as well as clusters of arrests and high threat areas. It virtually eliminates the waste of precious man hours and resources by identifying areas in need of monitoring. This is crucial as many parks are understaffed, underfunded, and responsible for vast expanses of land. Patrols that use SMART technology enable transparent monitoring of the effectiveness of anti-poaching efforts by park authorities and community groups. SMART has proven to be highly effective in empowering park staff, boosting motivation and increasing interdictions and arrests.

SMART data comes from various sources. Rangers use handheld GPS communicators, cell phones, or satellite phones to log and relay information while on patrol. They use these not only to communicate with other rangers, base camp, and law enforcement, but they also track their own movements and mark areas of interest. GPS locations of spent shell casings, cut wood, mining camps, tracks, and any other signs or evidence are all logged and stamped with location, time and date.

CHAPTER FOUR: PATROLLING AND COMMUNICATIONS (cont.)

Cellular trail cameras are also important for feeding critical, time-sensitive information to rangers on SMART patrol. The cameras send information immediately to email and cell phones for analysis, giving ranger patrols the opportunity to locate, intercept, and if necessary, apprehend and possible criminals. All of this information is put into a database and then projected into a map format, allowing rangers and management to strategically target criminals and areas most prone to wildlife crimes.



Focusing manpower and resources on high-risk and high-incident corridors results in more arrests and better prevention of wildlife crime. SMART provides us the best opportunity to effectively protect national parks that are understaffed, underfunded, and where rangers suffer from a lack of equipment and training.

Global Park Defense software requires some initial training. Jeff Morgan with AKNP Rangers.

CHAPTER FIVE: COMMUNITY INVOLVEMENT

No park and wildlife protection strategy can work without community involvement, from re-training poachers to be rangers to building strong informant networks. Developing tourism income and activities with local communities reduces the chance of local people becoming involved in illegal activities. National parks in developing countries have large stakeholder groups in the surrounding communities, which are critical to long-term protection. Key programs include:

Stakeholder support, especially support from the communities surrounding national parks. In order to protect national parks in the long term, park authorities must join forces with local community stakeholders. Global Conservation funds community involvement programs including Eco-Guards, tourism cooperatives, and park ranger and management training.

Basic living support, or helping the community develop solutions for their basic needs such as clean water, is important and builds trust. Solutions should be developed and executed jointly. A lack of basic resources leads to starvation, sickness, crime, and a whole host of other societal problems that ultimately can lead to wildlife crime and a lack of cooperation with authorities. We reaffirm everyone's right to basic resources and we work to establish a plan to ensure communities involved in our projects have access to these basic resources and services.

Anonymous informant reward systems can be a successful tool in making arrests and gathering intelligence when properly initiated. All information must be vetted before action is taken. Good information can lead to arrests, seizures of illegal goods, and the prevention of wildlife crimes before they happen. It's critical to compile reliable information into a database as well. Informants are financially compensated for information leading to arrests and prosecution of illegal activities such as poaching, hunting, mining or logging. This can be a good way to build community relations by directly benefiting community members while simultaneously protecting parks.

Spotlight: Sierra del Divisor

It is important to have the local community on your side because they know the practices, norms and landscape better than anyone. Integrating them into conservation projects is a win for both the communities and for conservation. In Sierra del Divisor National Park, Peru, we have made great strides working directly with local communities on two fronts: law enforcement and ecotourism. We are currently collaborating with two communities, Nuevo Sapasoa and Patria Nueva.

On the law enforcement front, Sierra del Divisor management has relied on the communities as guides and a source of information. Unfortunately, the practice of hiring community members as rangers has been a challenge. The value of hiring local community members is often overlooked by bureaucrats that make hiring decisions in the capitol, and rangers are often brought in from larger cities.

Spotlight: Sierra del Divisor (cont.)

Since we arrived in Peru we have established a working relationship between the military, the special police, and the community, and we will soon incorporate the rangers into this relationship. Thanks to these partnerships, the community no longer fears reprisals from criminals and feels more free to report criminal activity.

An attack on the community would most likely provoke a response by the military. Joint patrols are often a result of information gathered by the community and have a greater chance of arrest and conviction.

Peruvian women create traditional textiles for sale to ecotourists in Sierra del Divisor National Park, Peru

At the same time, we are working on a community garden and clean water project to improve health within the community.

In terms of ecotourism, we will employ local community members at the park's ecolodge, currently under construction. They can also offer tours of their community and sell their native goods to tourists. They will also be able to sell fresh produce from the garden and fresh fish to the ecolodge.

Spotlight: Akashinga Rangers

The Akashinga Rangers is a community-driven conservation model led and implemented by the International Anti-Poaching Foundation (IAPF), empowering disadvantaged women to restore and manage large networks of wilderness areas as an alternative economic model to trophy hunting.

The Akashinga are a highly-trained, quasi-military group of women that are charged with enforcing anti-poaching laws in their own communities, at times even arresting their own family members. IAPF has discovered that when women are at the center of community-led conservation, they can focus on their education and development. That leads to cascading benefits for the community, where conservation becomes an automatic community-led by-product.

Akashinga aims to recruit 1,000 women, protecting a network of 20 former hunting reserves by 2025. The vision of Akashinga is to replace trophy hunting as a management tool for conservation in Africa. This achieves landscape conservation at scale: A balance of ecology, economics, ethics and politics for the long-term preservation of large wilderness areas run by women. At the same time, the Akashinga model injects 62% of operational costs back into the community, 80% of which reaches the community at the household level. The Zimbabwe pilot project returns the same amount of money to the community every 34 days that trophy hunting did every year.

The program was started in Phundundu Wildlife Area and Wilderness, which borders Zimbabwe's Mana Pools National Park to the south. The Akashinga program builds an alternative approach to the militarized paradigm of 'fortress conservation', which defends colonial boundaries between nature and humans. While still trained to deal with any situation they may face, the team has a community-driven interpersonal

We are supporting the Akashinga Rangers in Mana Pools, Zimbabwe with Global Park Defense.

focus, working with rather than against the local population for the long-term benefits of their own communities and nature.

Akashinga is a platform for women to change the world for the better. These women, many of whom are survivors of domestic abuse or sexual assault, are excelling at one of the most demanding and respected jobs in the world while simultaneously improving their own lives, their families, and their communities.

Some critics are questioning the effectiveness of sending women to intercept notoriously dangerous and violent poachers. Akashinga's founder, former Australian army sniper Damien Mander, simply points out the undeniable results: since 2017, the Akashinga Rangers have made hundreds of arrests and helped to drive an 80% decrease in elephant poaching in the Lower Zambezi Valley.

CHAPTER SIX: TRAINING

Rangers and Eco-Guards are the first and last line of defense for nature. Ensuring that rangers are properly trained and equipped is vital to effectively deterring and prosecuting illegal activities. Further, ranger recruitment offers job opportunities to people from local communities. We are dedicated to community-driven conservation that empowers the disadvantaged to protect their wildlands.

Rangers and Eco-Guards are the frontline of defense. Ongoing and constant training for rangers is a key component of Global Park Defense. Basic patrolling skills, firearm safety, first aid, navigation, and communication are all focal points. Training rangers on new equipment and tactics is imperative. The training also gives rangers the confidence and enthusiasm to embrace the new program. Learning new tactics and how to operate new equipment as a group also builds comradery.

Community Eco-Guards are unarmed guards recruited from the local community. Eco-Guard programs allow us to increase the size of patrol teams, capitalize on local knowledge, recruit young people to complement more experienced rangers, and offer local community members a lawful livelihood. Many Eco-Guards are reformed poachers or loggers.

Management and technical training is equally important. Data from equipment and reports must be handled and assessed competently to provide the best opportunity for rangers and law enforcement to make arrests and interdictions. Meetings between staff should be carried out regularly and equipment and software should be updated often. A manual for general protocols should be developed.


WILDLIFE
ALLIANCE

CHAPTER SEVEN: ENFORCEMENT

When wildlife poachers and illegal loggers have no fear of park authorities and the legal system, park protection and law enforcement is impossible. We work to ensure wildlife crimes are punished and publicized to discourage others from entering the national park illegally for logging, mining or hunting.

Forging a relationship between the military or law enforcement and park authorities is vital to successful prosecutions. Oftentimes, laws are outdated, feckless, or confusing; it's best to first build a foundation for successful prosecutions by altering existing laws or creating new laws and policies that provide clarity for park management, rangers, and law enforcement. Standard protocols should be recognized by all parties involved.

Park border demarcation is one of the selection criteria for our sites, as clear demarcation discourages illegal activity and assists in prosecution. We require that the park director secure a budget and install 30% of the park boundary. We install Global Park Defense signage at every 500m on all trails and roads to provide information about surveillance and patrols in the area.

Alliances are of the utmost importance when implementing GPD. Jurisdictional issues are a factor in many parks. Understanding who has arrest authority and the right to detain, as well as the potential obstacles to successful prosecution, are imperative. Bringing multiple forces together increases the chances of a lawful arrest and successful prosecution.

Introducing yourself to government and non-governmental organizations working in the area is beneficial to all parties. Resources can be pooled and tasks can be assigned in a more efficient manner.

Investigations should always be done in the most thorough and methodical manner possible. There are a few tactics that should be practiced whenever conducting an investigation. Ask the basic questions: who, what, when, where, why, and how. Who is the person you are talking to, what are they doing, why are they there, etc.

Look for inconsistencies in a suspect's story or hesitation in response to your questions. Demand definitive answers to your questions and take notes. This allows you to lock them into a story. It will be easier for them to change that story if you accept vague answers.

A few digital intelligence tools are becoming more widespread in conservation investigations. One is Cellebrite, a software solution that can retrieve information from a suspect's cell phone, even if that data has been deleted by the user. Law enforcement officers can confiscate a suspect's cell phone and run it through the Cellebrite Mobile Forensics tool. The tool can then extract data from any cell phone, can be used in the field, and can add the extracted data easily to most intelligence database software. This also extracts the suspect's phone number, which can then be brought to mobile network providers to retrieve personal information, geographic tracking, and user history. Mobile airtime scratch cards found at crime scenes can also be linked to phone numbers with the help of the mobile service provider. The internet, including websites that collate data on individuals for a fee and social networking sites, can also help investigators build a profile of a suspect.

A database of all of the information gathered during arrests is a great reference point during investigations and keeps record of repeat offenders. Whenever stopping or arresting an offender, a clear and up-close picture should be taken and

a profile containing their information should be entered into the database. This way, if they are stopped or arrested in the future by a different ranger, the perpetrator would be recognized as a repeat offender and treated accordingly.

Specialized intelligence database software like IBM i2, which despite its expense is becoming the industry standard, is an excellent way to do this. IBM i2 allows investigators to input all forms of raw intelligence into a unified database, grade the quality of the intelligence, and then reveal relationships within the data. Without the ability to collate all intelligence collected, important linkages might be missed, which greatly diminishes the value of the data.

A citation system is a way to keep track of offenders and to provide evidence to police for an investigation that can be done at a later date. In many instances, rangers do not have arresting power and lack immediate support from local police and military. Even with an arresting force nearby, enforcement of laws can still be challenging if rangers lack the power to detain suspects while they wait for police.

Police forces often lack resources to respond immediately but can open investigations based on evidence and citations given by rangers. It also gives some authority to rangers in the difficult position of being forest monitors.

Training **prosecutors** is important as most have little experience with forest and wildlife crimes. Making arrests has little effect if the prosecution arm is weak. Oftentimes, small fines and warnings are all that get handed down for repeated wildlife crimes. They are often wrongly perceived as a minor issue in countries that already lack the proper resources to effectively combat violent crimes.

Training young prosecutors gives the opportunity to express the importance of wildlife and forestry crimes and their impact on the planet, their economy and the local communities.

For rule of law to be effective, the prosecutor must apply the laws consistently and fairly.

Spotlight: Using GPS Tracking

The use of advanced investigative and surveillance tactics has resulted in great success for us so far. GPS tracking devices, for example, have greatly changed the landscape of conservation and protection. These devices can be placed inside ivory and other illegal animal trophies, illegally harvested logs, or even on vehicles.

Illegal loggers will often cut down a number of trees and return for them later. Poachers often employ a similar strategy: they will shoot the animal and leave the scene to ensure their escape, and the perpetrators or other conspirators will return for the parts at a later time.

In the past, rangers would respond to the dead animal or fallen trees and stand guard, waiting to ambush the criminals or simply deter them from returning. In that case, rangers may arrest a low-level scout or syndicate member sent to retrieve the parts, but usually the criminals know they're being watched and evade arrest.

With tracking devices, we can drill a small, inconspicuous hole and place a device inside the contraband. Rangers can respond quietly, set the device, then retreat and allow the criminals to return for their illegal items without knowing they are being watched and followed. We then can track these illegal items up the criminal chain, making high-level arrests along the way. In some cases we can track items all the way to the shipping containers that export illegal goods in bulk.

CHAPTER EIGHT: FINANCING FOR SUSTAINABILITY

Few organizations can fully fund everything that is needed for a conservation project to be successful, much less fund it indefinitely. The only way for a protected area to be successful in the long term is for it to find permanent revenue streams.

Tourism is one good way to do this, as is a mix of government support and private funding. It's best to have multiple revenue streams in case there is a problem with one of them. We're dedicated to making sure that each of our GPD projects has sustainable funding in place by the time we conclude our program.

Non-profit funding is often the first type of funding available to a protected area in a developing country, aside from government funding. Some NGOs, like us at Global Conservation, provide a fixed-length program like Global Park Defense, or just targeted support like ranger training. In some cases, NGOs will fund science but do not have extra resources for forest and wildlife protection.

Early in the process of deploying Global Park Defense, we evaluate the level of current funding from the government and revenues from tourism to support ranger salaries and park operations.

In general, Global Conservation does not fund vehicles, salaries or capital costs like new ranger stations, bridges or roads. In some cases, we have built Command Centers (Murchison Falls National Park, Uganda) and in very special cases, we have provided the first truck in the park's history, like the Mitsubishi 4x4 in Carpathians, Ukraine.

Global Conservation funding has a number of advantages over government bi-lateral or multi-lateral funding. Firstly, none of our money goes to governments. Secondly, we can fund programs immediately, not after 1-2 budget cycles, and finally, our funding is specific to our Global Park Defense program and most costs are clear from the onset.

Some non-profits, like African Parks, will secure an exclusive concession with a national government and take over complete budget and responsibility. But, very few UNESCO World Heritage sites and top national parks will be protected under this model, and the national government/ ministry of environment must work to secure both domestic and international funding. In any case, non-profit funding is usually limited and programs tend to run for a fixed length of time. Consequently, long-term funding needs to be secured from other sources in order to sustain park protection after an NGO concludes their program.

Government budgets should match GC funding, or governments should at least start kicking in major funding and improvements in the first two years. We request matching before we begin our 4-5 year program, knowing some parks will need 2-4 years to secure new funding. Most governments in developing countries have small budgets for nature conservation and park and wildlife protection, and national park leaders must advocate and negotiate stronger budgets from their governments.

We work with park leaders before committing funding to request matching support for GPD deployment - improving roads, buying vehicles, increasing staff, building ranger stations and visitor centers, etc. A tip: the best time to get new budget concessions from the government is before we kick off the Global Park Defense program. Early government buy-in is important to increase the probability that they will continue to invest in the park long-term.

Spotlight: Funding Mirador National Park

Private philanthropic funding has played an important role in the long-term sustainability of Mirador National Park, Guatemala. For Mirador, we secured over US$15 million in private philanthropic funding, including over $5 million from Guatemalan families and corporations. When the country's families and businesses come together, they enable the government to tackle larger protected areas and secure stronger funding.

In Mirador, Guatemalan citizens and businesses joined forces for the first time to fund protection and conservation of their national heritage. These funds have been instrumental in protecting over 240,000 hectares of intact tropical forests and wildlife habitats. Direct financial support from local communities and businesses helps instill a sense of ownership and pride over the country's natural heritage.

In Mirador National Park many agencies and NGOs coordinate efforts to protect this huge critical area.

CHAPTER EIGHT: FINANCING FOR SUSTAINABILITY (cont.)

Tourism income plays a crucial role in the long-term sustainability of a project. UNESCO World Heritage Sites often have great opportunities for tourism, and long-term protection can often be paid directly from visitor fees.

One strategy is to focus on three key destinations within the park where ranger and tourism presence can deter poaching and illegal logging, and where business can be sustained, generating critical revenues and employment. However, as we have seen during the ongoing COVID-19 pandemic, longer-term government funding is always critically important in case there is a temporary drop in tourism. This government funding must be able to temporarily sustain protection, ranger salaries and patrol operations. Unfortunately, in times of crisis, ministries of environment and culture tend to be the first to be gutted by budget cuts, despite already having limited funding.

Philanthropic support from private entities or foreign aid is critical for our greatest national parks. Global Conservation works with park leaders to find and organize all funding sources, and introduce our partners to donors, both foundations, foreign governments and international programs, like the U.S. Fish and Wildlife Service or Coca-Cola. Park leaders must be uncorrupted and dedicated, and know that long-term funding takes years to secure.

Emergency/reserve funds for patrol support are invaluable. Often in government bureaucracies, getting cash to buy food and fuel takes months, and no money is readily available for emergencies (fires, helicopter, boats, injuries).

Non-profit funding can assist with this; Global Conservation funds have an advantage over government funding, because we can fund programs immediately, not after multiple budget cycles.

CHAPTER NINE: MARINE PROTECTION

Our oceans are under siege. Many of the world's coastal marine ecosystems have been trawled, polluted, and overfished, and marine protected areas (MPAs) have become our last strongholds for protecting intact coastal and reef ecosystems.

MPAs provide a sanctuary for fish and other marine wildlife, allowing fisheries to regenerate, maintaining healthy coral reefs, and supporting resilient marine ecosystems. In many developing countries, coastal MPAs are important centers of fishing, diving, and tourism, providing a critical source of food and income for local communities.

Despite their importance, illegal activities continue to deplete MPAs worldwide. Under our Global Park Defense program, Global Conservation focuses on providing the systems, technology and training needed for the protection of marine protected areas. While many GPD principles are the same for terrestrial and marine parks, some special consideration is needed when protecting our oceans. Global Park Defense provides a low-cost, highly effective system for protecting endangered MPAs, helping marine park authorities to detect suspicious fishing activity day or night.

Key aspects of GPD for MPAs:
- Marine Monitor Radar (M2 & M3)
- Long-Range Cameras
- UAVs (Drones)
- SMART Marine Patrols
- Marine Warden Capacity Building

Working with the Anthropocene Institute, Wildcoast, NOAA, OneReef, ProNatura, Coral Triangle and other conservation partners, we are scaling up Global Park Defense for marine park protection globally. Currently, Global Conservation funds deployment of Global Park Defense in twelve MPAs worldwide.

Marine Monitor Systems We partner with the Anthropocene Institute to deploy their Marine Monitor (M2) systems, which provide radar for fishing inspectors and wildlife rangers.

The M2 is a low-cost, radar-based monitoring platform for MPAs. The M2 system uses off-the-shelf, commercially-proven radars and open-source software to enable managers of MPAs to track over 30 vessels in their area in real time. This allows those enforcing rules and regulations to efficiently allocate limited resources, which are otherwise wasted patrolling the vast ocean.

Global Conservation is scaling up M2 deployments in UNESCO World Heritage Parks like Palau Northern Reefs, Jardines de la Reina in Cuba and Cabo Pulmo National Park in Mexico.

Global Conservation is also excited to support research and development of next-generation marine-hardened, off-grid Mobile Marine Monitor (M3) trailer systems, which can be shipped in standard shipping containers anywhere in the world. We can now fit two fully-working M3s in a shipping container and deploy globally.

Using SMART technology to integrate data from M2s and M3s with other information sources, marine park rangers are making more poaching arrests. In the marine forum, GPS, radio communication, laser & microwave sensors, and radar are used to monitor oceans and ports.

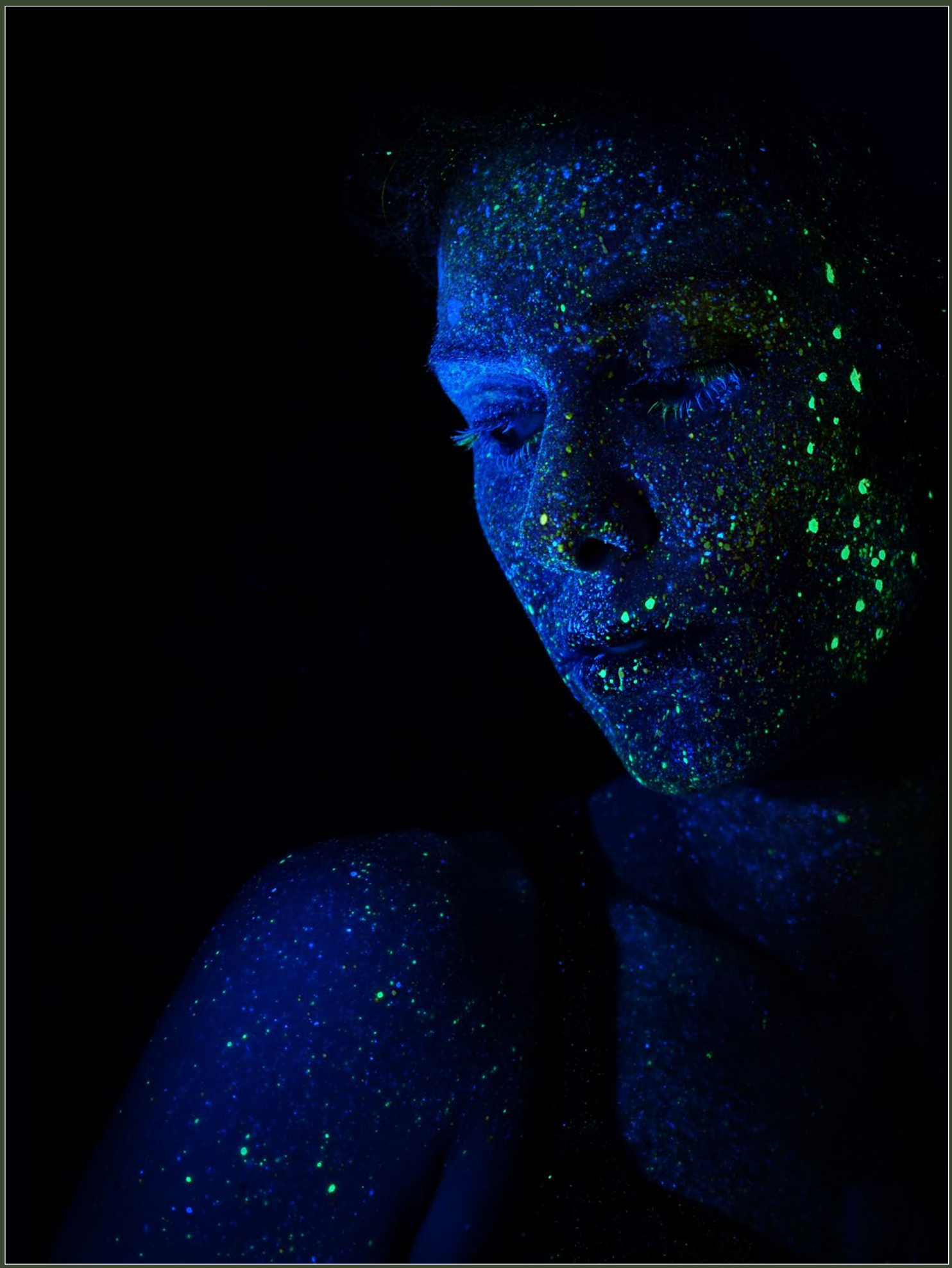
Like on land, the SMART system compiles important information about hotspots, fishing locations, smuggling routes, arrests, etc. All of this information makes patrolling and responses much more efficient. Targeted patrolling is especially key because of the vast expanse of the ocean.

CHAPTER TEN: SCIENCE FOR CONSERVATION

Science is a crucial component of Global Park Defense. Without ecological monitoring, we can't possibly know what we need to protect or how to measure the success of our efforts.

For each of our projects, Global Conservation funds wildlife population baseline estimates and 4-year progress studies. Here are a few examples of how scientific studies have helped to inform Global Park Defense.

The jaguar is the largest feline in the Americas. In the Mirador-Calakmul Ecosystem, Global Conservation and partners are protecting this critical species by monitoring their populations with Global Park Defense.



Murchison Falls: Multi-Species Aerial Baseline Surveys

In Murchison Falls National Park, Uganda, where wildlife populations are still recovering from massive poaching in the 1970s and 80s, scientists are using cameras mounted on light aircraft to count animals with Global Conservation's support. Traditionally, these counts were conducted by an observer sitting in the aircraft, but studies have shown that human observers often fail to detect some animals, biasing the population estimates. Human observers are often overwhelmed by large herds of animals that only remain in sight for about 5 seconds. On the other hand, cameras capture a permanent image of the herd so that the animals can be more accurately counted at a later time. The use of thermal imaging can further reveal wildlife that is well-camouflaged.

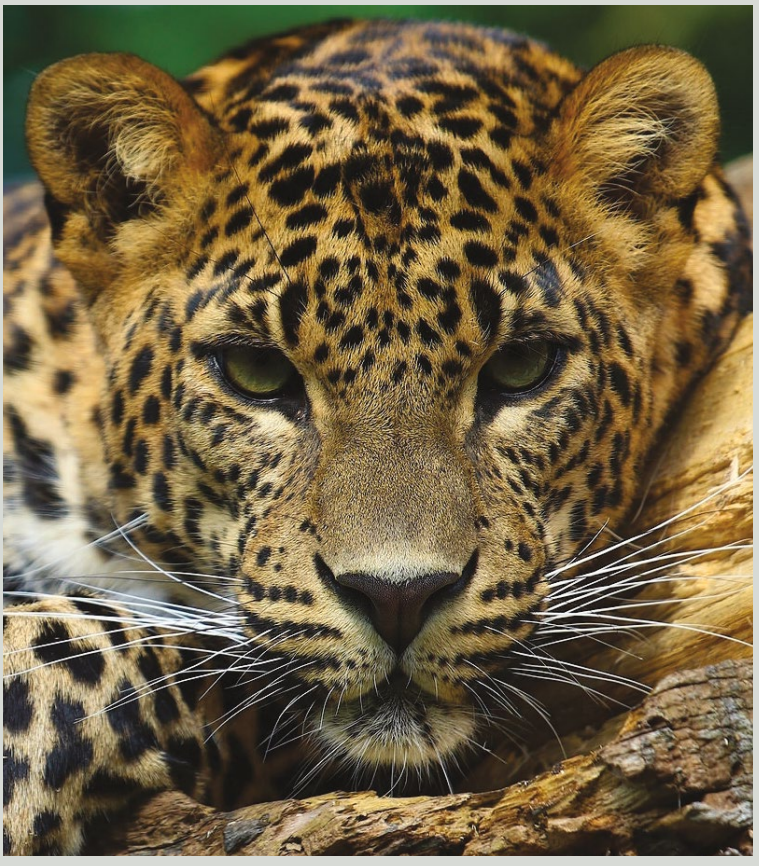
By calculating camera angles, focal lengths, altitude and frame interval, scientists were able to create strips of images of a known sample size to the left and right of the aircraft. Those high-definition images were then analyzed visually, and the scientists' counts of animals within the photos were used to derive population estimates for multiple wildlife species, including hartebeest, elephant, giraffe, Uganda kob, buffalo, waterbuck and oribi. This camera-based method was more accurate than traditional methods.

Using this method, scientists increased the national population estimate for Uganda kob by 77%, from 77,759 to 137,736. Regular aerial counts will allow scientists to monitor population changes, allowing conservation managers to better plan for the future and informing policy makers of the status of wildlife populations.

Mirador-Calakmul Ecosystem: Jaguar Monitoring

After the Amazon, the 14.2-million-hectare Mayan Forest is the largest continuous tropical forest in the Americas and is one of the most important areas for the conservation of biological diversity in the world. This vast expanse of forest is home to the jaguar, the largest feline in the Americas, with a distribution ranging from northern Mexico to northern Argentina. Over the past 50 years, jaguar populations have been shrinking due to habitat loss and fragmentation, poaching, and an increase in human-jaguar conflict.

In order to develop a conservation strategy for the jaguar now and to understand in the future how conservation actions have impacted jaguar populations, Global Conservation recently funded a three-year scientific baseline population study for jaguar and prey in Mirador National Park, northern Guatemala and Calakmul World Heritage Park, southern Mexico.



The study's primary objectives were:

1. To determine jaguar abundance and density at El Mirador, Guatemala, and compare to Calakmul, Mexico where studies had been ongoing for three years.

2. To determine the jaguar's prey base and feeding habits at El Mirador, Guatemala, compared to Calakmul, Mexico.

3. To establish a baseline study to evaluate the long-term conservation of jaguars and their prey at El Mirador, Guatemala.

CHAPTER TEN: SCIENCE FOR CONSERVATION (cont.)

Having baseline data on jaguar and prey population numbers and distribution allows us to answer questions like:

1. Five years from now, how has the implementation of Global Park Defense impacted the populations of jaguars and their prey?

2. How is jaguar distribution changing in response to changing threats, such as logging or land development at the edge of forests?

3. Might changes in jaguar numbers be attributable to changes in prey populations, or are they caused by something else?

Like other big cats, the study and monitoring of jaguars is difficult due to their large home ranges, low densities and cryptic nature. Researchers used camera traps for the study. During the dry seasons of 2018 and 2019, Cuddeback trail cameras were placed in a spatial arrangement of nine blocks of 9km^2 each (3 x 3 km). Four cameras were placed within each block to capture images that would allow scientists to identify jaguar individuals by the spot patterns on their coats. The cameras were kept active 24 hours a day for 73 continuous days, with a total sampling effort of 2,628 trap days.

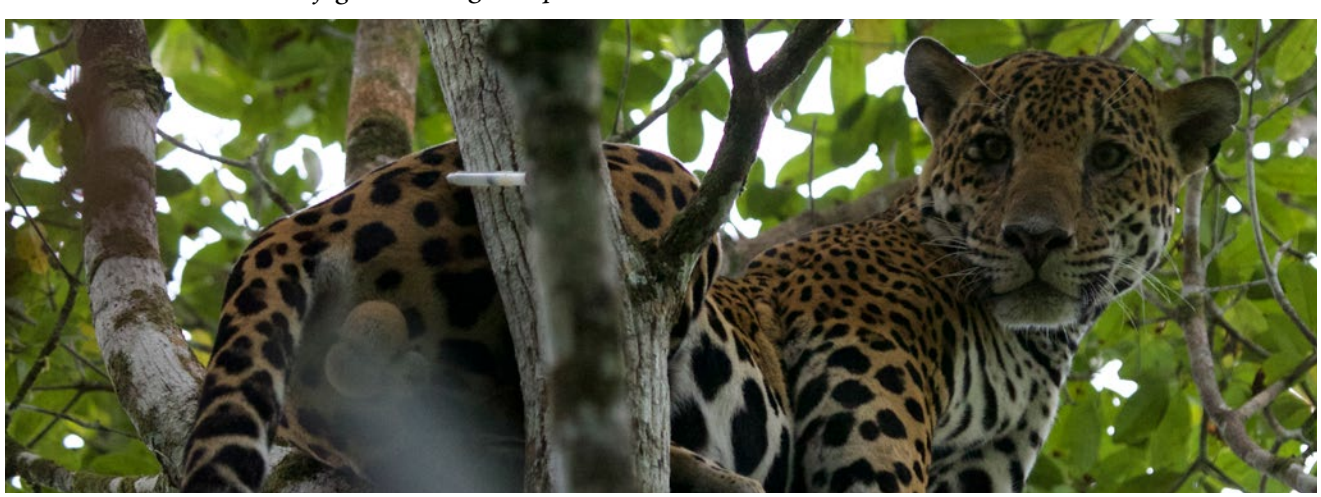
During the whole sampling period, a total of 25 individual jaguars were identified. Based on this information, jaguar density in Mirador was estimated at 7 individuals per 100km^2, similar to jaguar densities in the Mirador-Río Azul National Park and Protected Biotope Naachtún-Dos Lagunas, Guatemala.

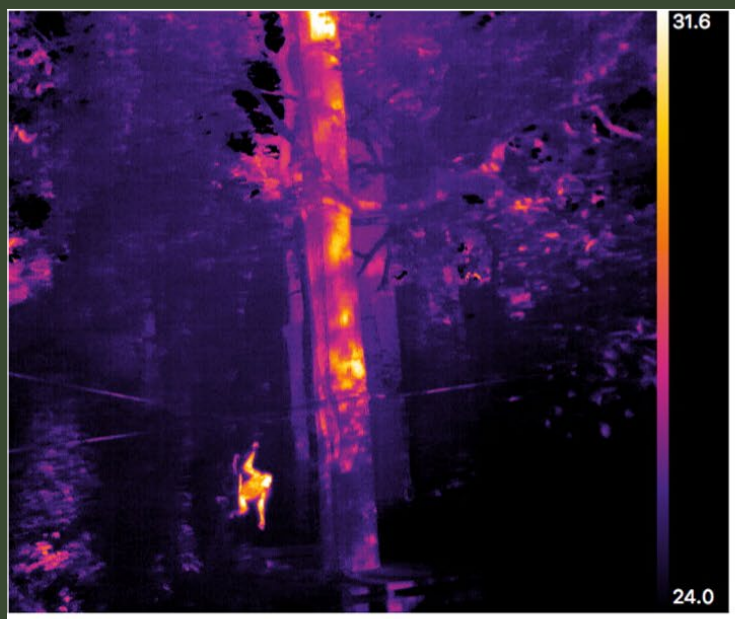
Altogether, these three sites with a total area of 870,815ha were estimated to have a jaguar population of 610 individuals. The results of this study confirmed that the Mayan Forest is an area of particular importance for jaguar conservation, with the highest jaguar densities north of Brazil's Orinoco River.

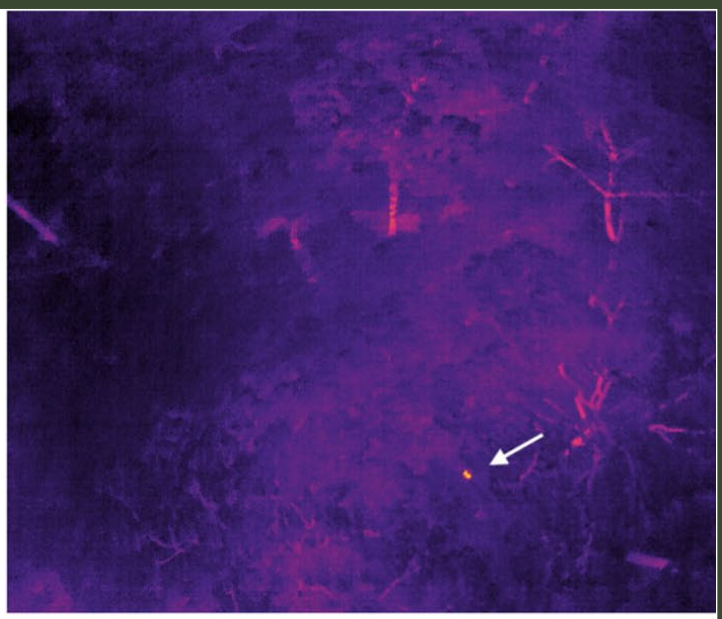
Massive loss of habitat across Mesoamerica, combined with hunting and wildlife poaching for profit, is putting major pressure on the jaguar's survival. This multi-year scientific study has obtained reliable and comparable density estimates key to monitoring wildlife populations across space and time.

For the first time in Guatemala and in the Maya Biosphere, we have the data to accurately detect jaguar population declines, estimate threats, and implement the appropriate conservation interventions needed.

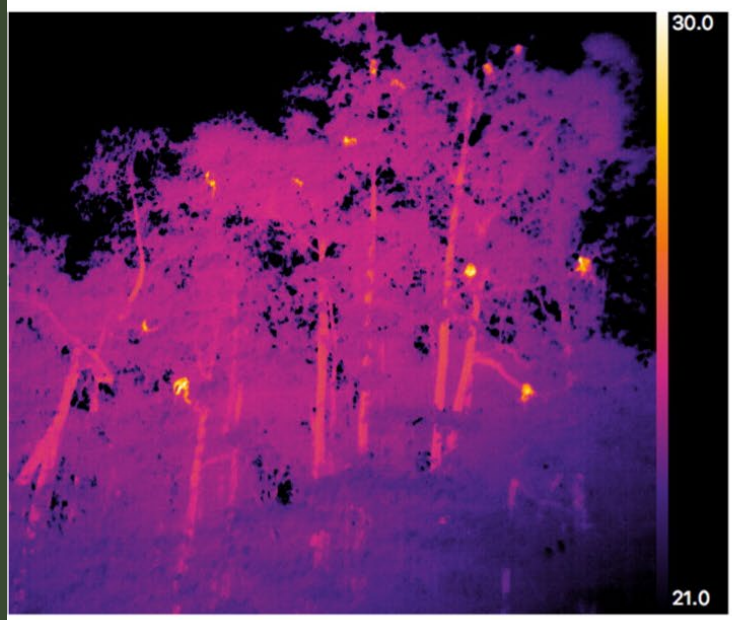
This jaguar is being tranquilized so that it can be studied and tracked.

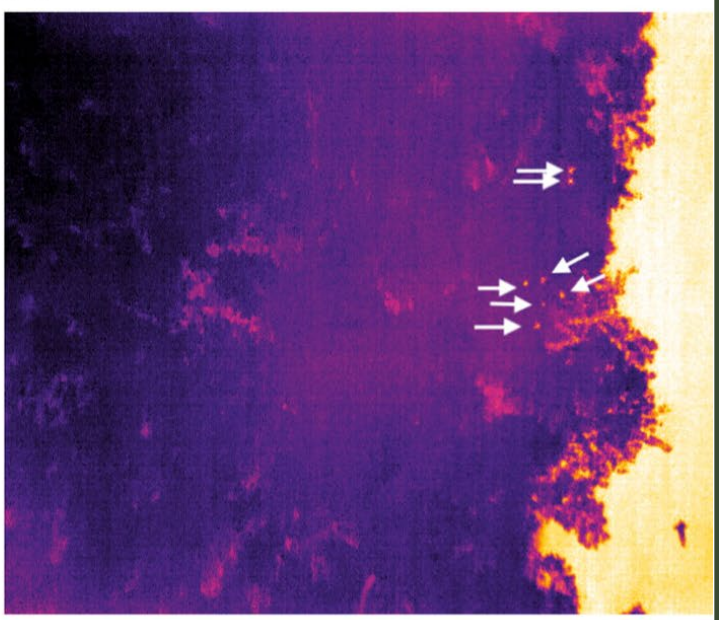




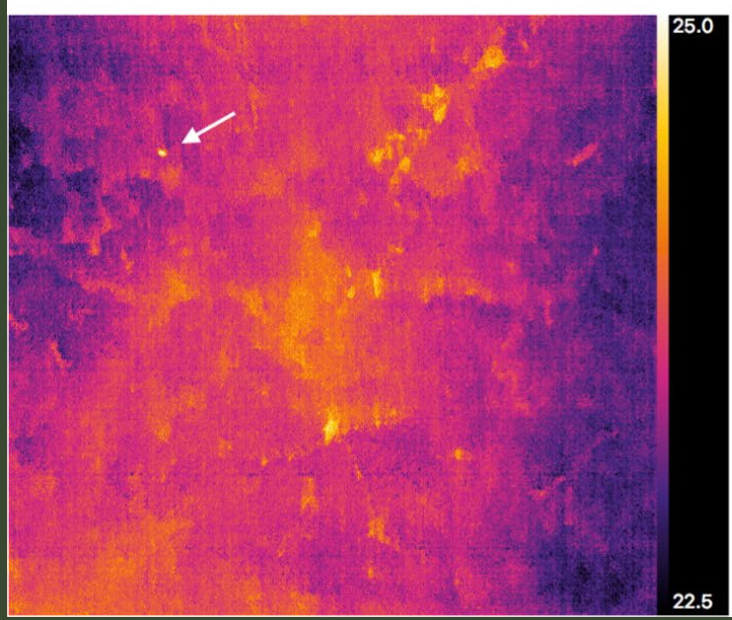


(d)





(f)



Leuser Ecosystem: Drone Monitoring of Orangutans

There are two species of orangutans alive today, and they are only found in the tropical forests of Indonesia and Malaysia. These highly intelligent apes are among our closest relatives, sharing 97% of our DNA. Unfortunately, both species are highly endangered, due to rampant habitat destruction fueled by an ever-increasing demand for palm oil. 90% of their habitat has been destroyed just in the past 20 years.

The Leuser Ecosystem on the Indonesian Island of Sumatra is one of the orangutan's last strongholds. The ecosystem spans 2.6 million hectares, almost three times the size of Yellowstone National Park. Its diverse landscape includes lowland and montane rainforests, nine rivers, three lakes, and over 185,000 hectares of carbon-rich peatlands. One of the last remaining intact rainforests in all of Indonesia, it is a crucial source of clean drinking water and agricultural livelihoods for over four million people.

Monitoring orangutan populations in the Leuser Ecosystem is particularly challenging. Traditionally, researchers have estimated orangutan populations by walking line transects through the rainforest and counting orangutan nests. However, their habitat is dense and difficult, requiring significant time and funding. Sometimes, researchers need to cut a path through the dense undergrowth, and they can typically only walk two kilometers of transect per day. With total transect lengths reaching 100km or more, research teams often spend the better part of a month conducting one survey. Methods that are

Opposite: Thermal drone video spots specific animals.

often used to estimate populations of ground-dwelling species aren't of much use; because orangutans move through the trees in three-dimensional space, camera traps are unlikely to capture them. Due to these challenges, researchers have been unable to conduct population counts at a high enough frequency to accurately monitor changes.

Researchers at Conservation Drones figured out that unmanned aerial vehicles (UAVs) could address this problem. By flying fixed-wing UAVs in a pre-programmed pattern above the forest, researchers could capture thousands of high-resolution images of the forest canopy. They could then scour these images for orangutan nests, producing an accurate count of the number of nests in a given area.

Although these nests must currently be counted manually, researchers are working on training artificial intelligence to detect nests in the images.

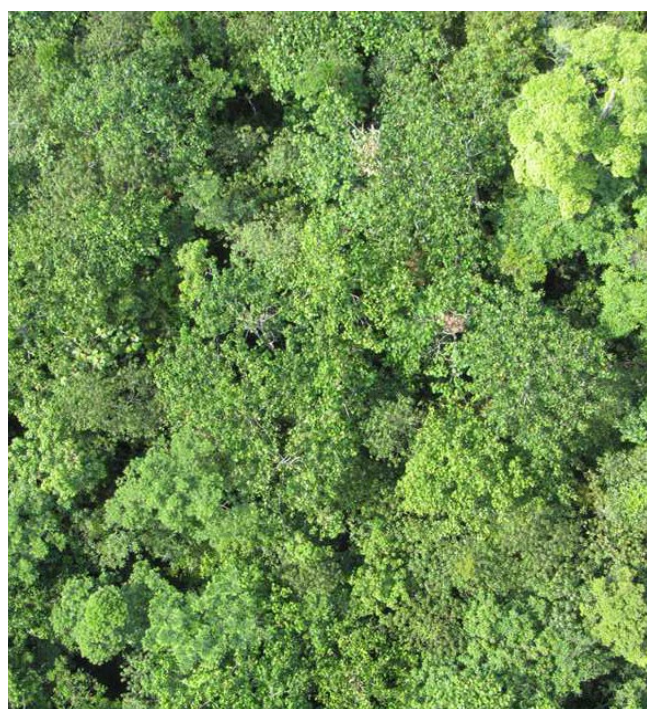
Researchers chose fixed-wing UAVs because they are faster than quadcopters and can fly further on a single battery. Even though fixed-wing UAV surveys are faster and cheaper than walking transects, able to fly 50km in 40 minutes, they tend to differ from foot-transect surveys in how many nests they detect. Therefore, the first step to implementing this new technology was to conduct both survey types in the same area and then compare the results. After doing this enough times, researchers were able to calculate the error and accurately estimate populations using UAV surveys alone.

Most recently, researchers have begun to add thermal cameras to the drones, helping them to detect orangutans even more reliably using their heat signatures.

This new method adds to the many uses of UAVs in conservation, including mapping land use types and forest cover, and anti-poaching.

By adding thermal cameras to drones, researchers can monitor orangutans more reliably using heat signatures.

Fixed wing UAVs are spotting known orangutan nest locations for monitoring populations in the wild.




H-KING
DIXLER
H-KING
DIXLER

Mana Pools: Carnivore and Elephant Collaring

Wildlife tracking collars are an important part of scientific monitoring at Mana Pools National Park, Zimbabwe. Our partners at the Bushlife Conservancy are working with ZimParks to build up a research program in Mana Pools and its surrounding areas. As of mid-2020, they have collared three lions, three hyenas, and one leopard.

It is hoped that by collaring these predators, their movements can be tracked, den sites marked and information on genes and diseases can be collected. Bushlife is hoping to get collars on another two lions, two hyenas, three leopards, four wild dogs, and one cheetah this year. This will open up research opportunities in the park for both local and international students and help inform their conservation efforts.

The researchers also re-collared three iconic elephant bulls to help identify them as iconic and prevent hunters from shooting them in the areas adjacent to Mana Pools. Although elephants with collars may legally be hunted, the collars are a way of safeguarding these animals as they act as a deterrent to hunters. In this way, Bushlife aims to conserve the large tusk gene in the elephant population. Meanwhile, female elephants are collared in order to monitor their movements for research purposes. Two more collars will go on elephants this year.

For this type of work, there are several different types of collars that can be used, each of which has advantages and disadvantages.

CHAPTER TEN: SCIENCE FOR CONSERVATION (cont.)

Radio collars, or VHF (very high frequency) collars, emit a pulsed radio signal that can be picked up by a receiver and antenna, allowing someone to locate and observe the animal on foot or with a vehicle. While radio collars allow an observer to find an animal, they do not store data on the animal's movements. Any location data must be taken manually by the observer.

GPS/GSM collars, on the other hand, allow continuous collection of location data because the location is stored within the collar or sent by cell phone GSM connection to the researchers at regular intervals. For that reason, GPS collars are better for collecting home range data, as they give a more complete picture of the animal's use of the landscape at all hours. GPS collars work by sending signals to networks of satellites in orbit around the earth, which are able to pinpoint the precise location of the animal and track its path as it moves.

Satellite collars are similar to GPS collars, but are able to directly transmit the data to a user's email or server. This is especially advantageous in areas with little or no cell phone signal, as in many wilderness areas.

GPS and satellite collars transmit the animal's location at preset intervals rather than on demand, but they may also have a VHF attachment to allow researchers to track the animals on the ground in real time as well. This is one benefit of VHF -- with a standard GPS or satellite collar, researchers usually cannot find the animal in real time to make behavioral observations.

One major consideration in choosing among these options is cost. Radio collars tend to cost about US$350-650, not including the cost of antennas and receivers. GPS collars are more expensive at around $1,000-3,500, with satellite collars being the most expensive option at around $4,500. Radio collars tend to have a longer battery life than GPS or satellite collars.

Some collars are equipped with studded plates that are designed to protect animals from becoming injured if a snare gets wrapped around their neck. All three collar types can be programmed to transmit a special signal if the animal has not moved for a predefined period of time, called a "mortality signal."

CHAPTER TEN: SCIENCE FOR CONSERVATION (cont.)

To help inform conservation decision-making, GPS and radio collars can help answer research questions like:

1. How does wildlife move in response to disturbances such as tourism, logging, or poachers in the area?

2. What is the home range of a given wildlife species in the study area, and consequently, how might habitat fragmentation affect its survival?

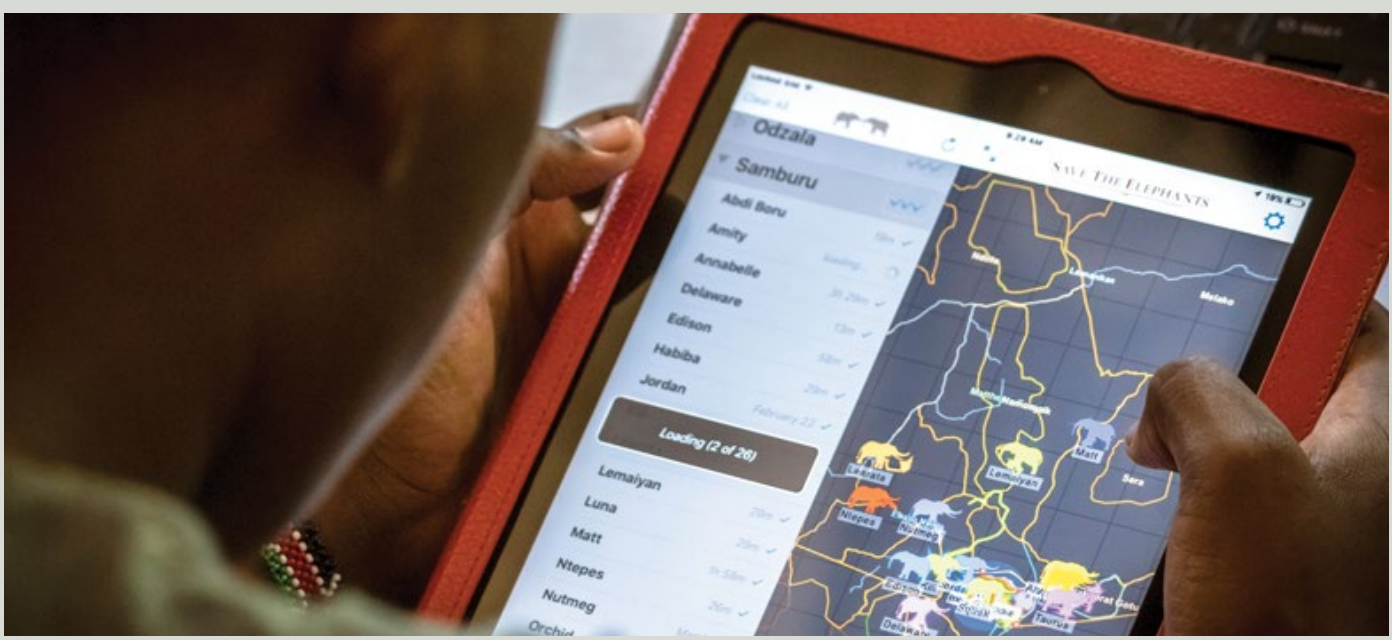
3. Which are the most dangerous areas for wildlife (are they consistently becoming injured or dying within a particular part of the protected area)?

4. How is a relocated animal adapting to its new area, and is relocation successful at keeping problem animals away from human settlements?

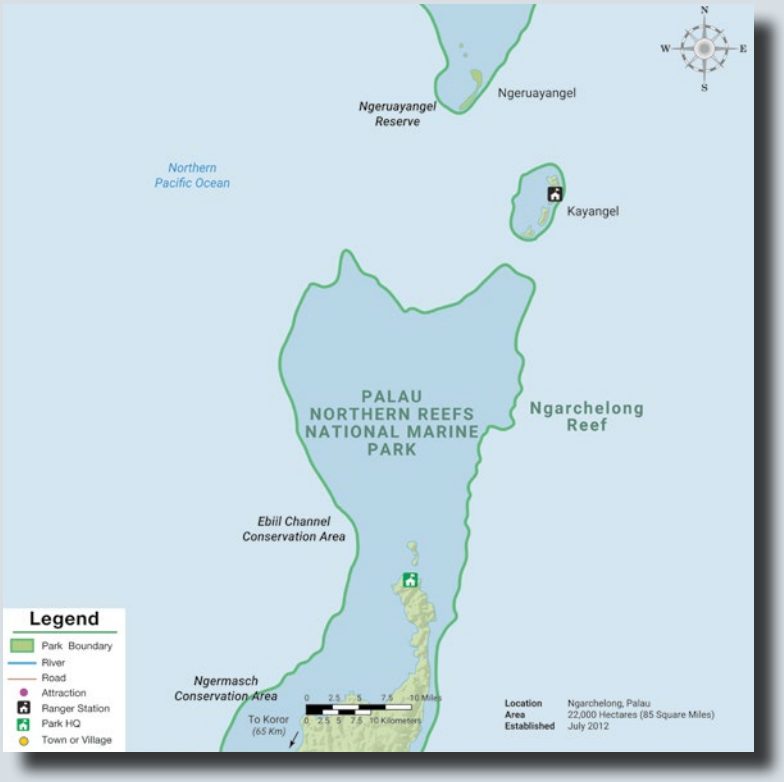
5. How do seasonal changes, natural disasters, or interspecies interactions affect animal movements?

Collaring one individual in a group of social animals like lions, spotted hyenas and wild dogs can help provide information about the whole group. In solitary animals, a collar can only provide information about the individual. In any case, wildlife collars are an important scientific tool for conservation.

Once collared, individual animals can be tracked and included in population surveys.



Palau Northern Reefs: Monitoring Fish Populations



Palau's ocean riches are many; its coral reefs are considered one of the seven Underwater Wonders of the World. In just one day, it's possible for a diver to see a menagerie of megafauna, from giant clams and manta rays to sea turtles, dugongs and fierce saltwater crocodiles that grow up to 4.5m long.

Palau's technicolor reefs contain more than 350 hard coral species, 200 soft corals, 300 sponges, and 1300 species of reef fish. However, there is concern across Palau that fish stocks are declining, especially with booming tourism and the resulting demand for fresh seafood.

Illegal fishing and commercial exploitation is threatening traditional communal fishing systems. In a given year, Palau faces 50 to 100 incursions by foreign pirate vessels. Some local community members also enter no-take MPAs illegally, often at night. As fish stocks decline in South Palau due to heavy domestic and international fishing, the protected Northern Reefs will be increasingly targeted by poachers.

The sustainability of a given fishery is determined not only by the sheer number of fish harvested, but also by the size of those fish. Harvesting smaller fish means removing individuals before they have the chance to breed, which reduces the overall ability of a fish population to replenish itself after a fishing season. Eventually, the stocks might collapse.

Marine parks and preserves are just as, if not more important than parks on land. We protect about 10% of our land surface worldwide. But less than 3% of our oceans are protected.

- Michael Sutton

CHAPTER TEN: SCIENCE FOR CONSERVATION (cont.)

Over recent years, fisheries stock assessments conducted in the waters of Kayangel and Ngarchelong showed the area is grossly overfished. According to fisheries data, nearly 70% of fish caught were immature or juvenile; fish are being caught before they have the chance to mature and reproduce.

In order for a fishery to be sustainable, enough breeding-age fish must be left to replenish their population. Should the situation continue as-is, the fisheries will no longer be able to support the livelihoods of communities or provide an economic benefit to Palau.

All of this means that fishing is becoming increasingly unsustainable in Palau, threatening the livelihoods of Palau's fishermen. Resolving this situation requires both effective regulation and enforcement.

Governments usually regulate the number and size of fish that fishermen are allowed to harvest, but to set those regulations, government officials must rely on scientific studies to determine what is sustainable. To understand whether current laws, regulations and enforcement were sufficient, or whether they were allowing fish stocks to decline, scientists at the Coral Reef Research Foundation studied the size of fish that were being harvested by Palau's fishermen.

The researchers used a compact 3D camera to film each fish that was caught at a particular landing site in Palau. Then, they used a specialized software called EventMeasure-Stereo to automatically measure the size of those fish. This method allowed them to quickly measure a large number of fish without touching them or interrupting the fishermen's work. Once they had these data, they compared them to historical data on the size of fish caught in the 1980's and 90's.

They found that the average size of most fish species captured has decreased, indicating that fishing of these species is approaching unsustainability. The number of large fish caught has also declined markedly, and many of the fish being caught are immature. For three common fish species, the scientists found that fishing pressure was already far above the sustainable rate.

After this study showed that fish stocks were in decline, the Palau Fishermen's Forum supported recommendations to (1) create a list of ten priority near-shore fish species that will be the targets of legislative reform proposals; (2) determine optimal, scientifically derived size limits for each of these species that protects more breeding-age fish; (3) identify spawning seasons, spawning sites, and other critical habitats for these species, and develop strategies for adequate enforcement; and (4) explore marine use zoning options that delineate areas for conservation, hatcheries, and specific types of fishing. It is hoped that these activities will help set reef fish stocks back on the path to recovery.

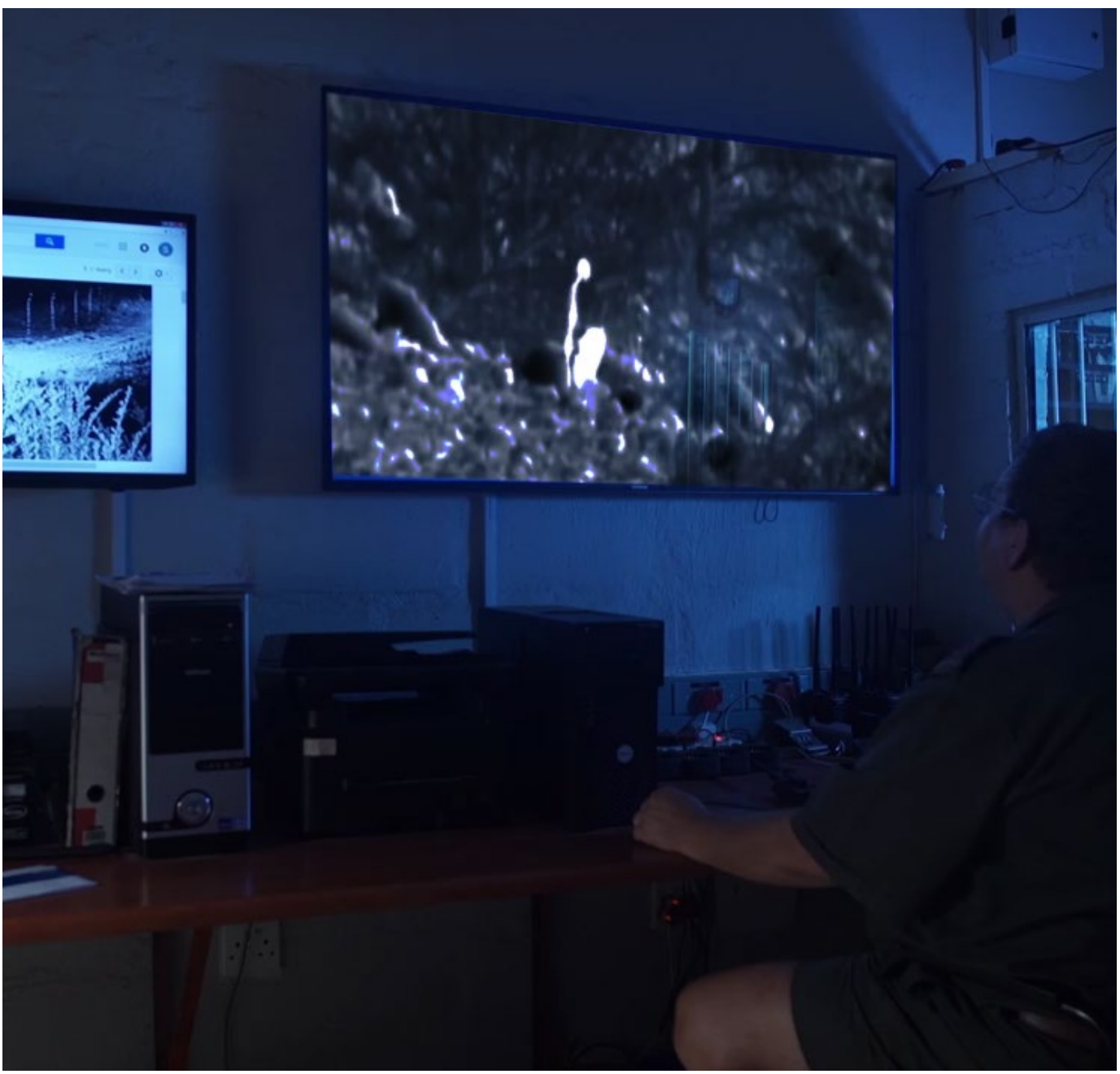
With adopted resolutions and public awareness of the problem, it is hoped that over time we will see improvement in the reef fish stocks. What's more, the data generated now can be used to assess the effectiveness of these interventions in the future. For that reason, this study also highlights the usefulness of historical data collection. The fish size data collected in the 1980s and 90s may not have been directly informative at the time, but it now provides a good baseline to assess changes over time.

It would also be beneficial to increase studies on the size at maturity of fishes in Palau, as without this parameter a biologically relevant size limit cannot be recommended.

Section Three

Technology for Global Park Defense

When applied correctly, technology can meet some of the needs that arise from underfunding, lack of training and manpower, and equipment issues, all of which are common problems in national parks. In this section you'll find information about some of the technological tools we use or plan to use for Global Park Defense.



CHAPTER ELEVEN: VULCAN EARTHRANGER

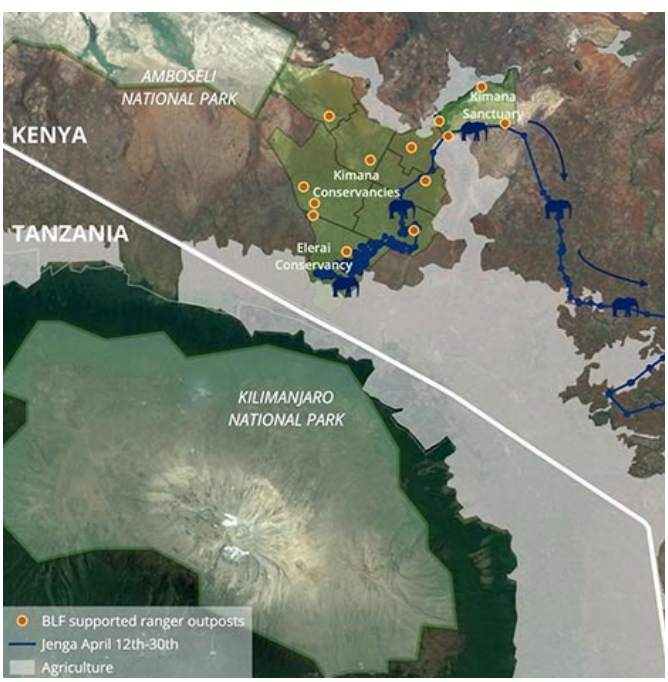
As the availability of technology increases, so does data management complexity. How does a conservation manager integrate a surge of incoming information from animal GPS collars, cellular trail cameras, field locations of snares from rangers on patrol, drone imagery, and satellite data in the most efficient way possible?

Vulcan EarthRanger solves that problem. EarthRanger is an easy-to-use online software platform that collects, integrates, and displays all available historical and real-time data from a given protected area. The software combines all of this data into a single, continuously updated map, so that managers can monitor the ecosystem, anticipate potential poaching threats or human-wildlife conflict, and react to ongoing threats in real-time.

Before EarthRanger, operations rooms contained multiple screens, each displaying different data, which were impossible to watch all at once. Even when they could monitor incoming information, it was difficult to visualize patterns between different data sets.

EarthRanger is a "one-stop data hub" that integrates multiple data streams that used to be housed on separate devices. This gives managers a complete picture of their protected area in real time, allowing them to more quickly deploy ranger teams in response to a threat. They can also use EarthRanger to analyze patterns, helping them to anticipate crimes and apprehend poachers before an animal is killed. Rangers and managers are now able to monitor the situation from afar and focus on interdiction rather than just response.

EarthRanger helps managers figure out how to allocate their resources most efficiently to stop poaching and human-wildlife conflict. For national parks and protected areas that are often



short on funds and staff, this "force multiplier" effect is crucial, making sure that rangers are in the right place at the right time. Further, it allows rangers to respond more quickly to potential threats, and the larger amount of information helps keep them safer.

CHAPTER ELEVEN: VULCAN EARTHRANGER (cont.)

Some examples of EarthRanger's capabilities:

1. Managers can monitor multiple wildlife GPS collars and set up alerts when an animal wanders out of the reserve or close to a village, allowing them to intervene when necessary and help communities to better coexist with wildlife.

2. Use computer vision and machine learning to tally the number of animals in photos captured by drones.

3. Law enforcement officials can track their ranger teams through GPS-powered walkie-talkies and accurately direct them to the location of suspicious activity.

4. Comprehensive visualization allows officials to track patterns that inform their patrol deployments – positioning themselves a step ahead of poachers.

5. Ecological monitoring, which improves scientists' understanding of the ecosystem's health, helps answer questions like, "How should we respond if there's a drought?" and "What does the ecosystem need to look like if we want to reintroduce rhinos?"

6. Outreach and education events can be input into EarthRanger, and analyzed in terms of how public programming impacts poaching numbers.

EarthRanger data comes from, among others:

- Ranger-recorded observations directly from CyberTracker-SMART Connect
- Radio systems with data transmission and GPS-tracking capabilities
- Animal collars
- GPS trackers in contraband, like rhino horns or illegal timber
- Informant information
- Spatial data layers that give geographic context, like hydrology, human infrastructure, and forest cover
- Sensor data from camera traps
- Vehicle sensors
- Drones and remote sensing images from satellites

The data are stored in a secure cloud platform and readily accessible to visualize through the EarthRanger web app, an iOS app, Google Earth or to be downloaded for further analysis within GIS software. A total of 20 locations worldwide are currently using EarthRanger, and since its first deployment in 2017, rangers and park managers have used EarthRanger to log more than 32,000 security reports, remove more than 13,000 snares and make more than 1,170 arrests.

CHAPTER TWELVE: GLOBAL FOREST WATCH

Forests are among the most important habitats on our planet: four out of every five plant and animal species live in them, and forests are critical for clean water, clean air, and combating climate change. Yet, they are being destroyed at a rate of fifty football fields a minute. In 2019, 3.7 million hectares of tropical primary forest were destroyed – the third highest year of forest loss in recorded history.

One of the reasons that deforestation is out of control is because it often happens out of sight of people who have the power to stop it. Analyzing satellite data can take years, and by the time large-scale deforestation is identified, the damage has already been done. It's hard to manage what you can't measure. That's where Global Forest Watch comes in.

Global Forest Watch (GFW) is an award-winning platform that was created by the World Resources Institute in 1997. In 2014, they launched a free, fully interactive online platform with forest monitoring data for the whole world, creating unprecedented transparency about the state of our planet's forests.

GFW makes the best, most recent data about forests available online for anyone to access, supporting smarter decisions about how to manage forests and allowing the public to hold governments and companies accountable for forest destruction. It works by using cutting-edge algorithms to harness the power of cloud computing and satellite technology to identify where trees are growing and disappearing in near-real-time. Officials and law enforcement can sign up for alerts to let them know when deforestation is happening, which allows them to stop illegal logging before more forests are lost. Business managers for companies can see if suppliers of commodities like palm oil, soy, beef, and lumber are clearing forests. Local community members can even report deforestation from their mobile phone when they witness it, and citizen scientists can help review data or use it to campaign for forest protection.

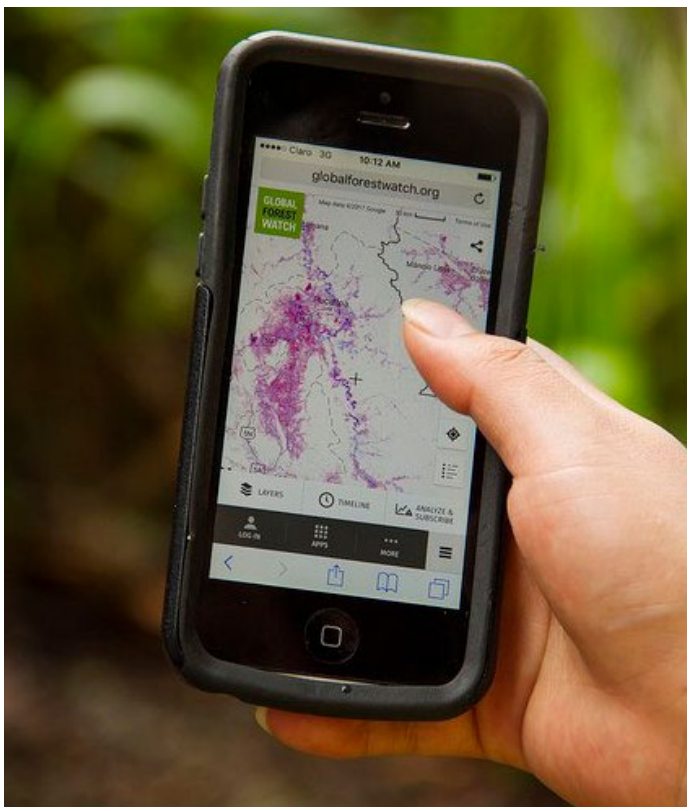
For Global Conservation's projects, one of the most important elements of GFW is the Forest Watcher app. Although satellite technology has recently allowed huge advances in our understanding of deforestation, that information is useless unless it gets into the hands of the people who can stop forest destruction. Forest Watcher allows rangers to access GFW data and Forest Watch alerts offline, which is critical in areas with limited to no cell signal.

Using cached data, the app directs users to nearby forest clearing and enables them to capture photos and fill out forms about deforestation, which are uploaded next time their device connects to the internet. The app connects satellite surveillance to boots on the ground, allowing rangers on patrol to know exactly where to look for deforestation and stop the illegal activity before it gets out of control. Forest Watcher is free, open-source, and available in English, Spanish, Portuguese, French, and Bahasa Indonesian.

CHAPTER TWELVE: GLOBAL FOREST WATCH (cont.)

Five categories of data sets are available on the Global Forest Watch platform: Forest Change Data, Forest Cover Data, Forest Use Data, Conservation Data, and People Data. Forest Watcher allows users to:

- Designate area(s) of interest to monitor
- Download various satellite-based forest change and other contextual data (e.g. near-real-time deforestation alerts, protected areas, and intact forest landscapes) onto a mobile device
- Navigate to alerts in the field, even without internet connection
- Collect information, including GPS points and photos, through customizable forms
- Review, analyze, and download data collected via the app



Global Forest Watch and the Forest Watcher app are used every day by governments, law enforcement, private enterprise, NGOs and the public.

CHAPTER TWELVE: GLOBAL FOREST WATCH (cont.)

Global Forest Watch and the Forest Watcher app are used every day by governments, law enforcement, private enterprise, NGOs and the public. Global Forest Watch Fires data, which is based on the NASA Active Fires data, were used to identify illegal burning that caused the 2015 Southeast Asian haze crisis. The same dataset is being used now to track the current global fires crisis. NGOs have used GFW data to track deforestation in Cambodia, which is now being exacerbated by the COVID-19 pandemic.

Our partners in Indonesia, HAkA, deployed Forest Watcher with global forest monitors in the Leuser Ecosystem. With Global Conservation's support, Global Forest Watch trained more than 40 Forum Konservasi Leuser (FKL) rangers and Aceh Forestry staff in satellite-based fire and deforestation monitoring. Rangers used to manually inspect raw satellite imagery, and then send patrols to the field with pen and paper to collect information. With Forest Watcher, deforestation alerts come straight to their cell phones, which they can also then use to collect GPS points, photo evidence, and notes on the deforestation event. This way, they can efficiently report evidence to local authorities for investigation and prosecution of illegal forest destruction.

Global Conservation also funded the deployment of Global Forest Watch and Forest Watcher systems with the Jane Goodall Institute (JGI) in Kibale National Park, Uganda. By using the Global Forest Watch platform in combination with mobile technologies to improve forest monitoring, GFW is helping to strengthen the work of JGI to protect chimpanzees and their habitats. The Budongo and Bugoma Forest Reserves in western Uganda are home to an estimated 1,157 chimpanzees. However, loss of forest in the vital corridors between these reserves threatens the connectivity and survival of these chimpanzee populations.

Global Conservation supports the legendary scientist's Jane Goodall Institute with Global Forest Watch systems.

Forest Watcher and GLAD forest loss alerts helped successfully detect new deforested areas along the park boundaries. *"Thanks to GLAD alerts, the park management were able to prevent further illegal activities and encroachment that could have spread deeper into the national park,"* said Timothy Akugizibwe, the Jane Goodall Institute officer in Uganda that is training rangers to use Forest Watcher.

"With Forest Watcher, we can now have intelligence-led patrols in Kibale National Park," reported Agaba Hillary Kumanya, a senior warden for ecological monitoring with the Uganda Wildlife Authority. *"We no longer go randomly to places, but instead know where to look for the latest forest loss."*

Global Forest Watch has been a true game-changer for the protection of our planet's forests.

CHAPTER THIRTEEN: SMART FENCE

Global Conservation is funding the construction of a Smart Fence in South Africa's Hluhluwe-iMfolozi Park (HiP), a rhino conservation hotspot and the oldest proclaimed game reserve in Africa. The new fence will detect and deter rhino poachers, protecting HiP's wildlife and keeping rangers safer.

HiP is often referred to as the "birthplace of rhino", as HiP's southern white rhino population saved the species from the brink of extinction almost 70 years ago. Since then, more than 3,500 white rhinos have been relocated from the HiP area to restock other parts of Africa.

Most white rhinos alive today originated from that remnant population. The park now contains the largest population of white rhino in the world and is also playing an important role in growing South Africa's endangered black rhino population. South Africa has about 17,000 white rhinos in total, estimated to be 80% of the world's population. They also have 2,000 black rhinos, about 40% of the world's population.

To protect this important rhino population, HiP, which is managed by Ezemvelo KZN Wildlife, has partnered with Wildlife ACT to construct a Smart Fence with funding from Global Conservation and the Wildlife Conservation Network. The Smart Fence detects any incursions or tampering along its length, and any attempt to infiltrate the fence triggers an automatic alert at Ezemvelo's control center. A rapid response team is then mobilized, allowing rangers to intervene and confront poachers before a rhino is killed.

"The fence has electrics both inside and outside its length and any tampering or cutting of the fence sends us an immediate message, pinpointing the location of the tamper. Two sections of fence have been upgraded to date and we have already seen a shift in rhino poaching activity away from both areas to sites where there is no detection fence," said Dennis Kelly, Section Ranger, Makhamisa.

Smart Fence technology is being used to protect the last rhinos on Earth.

CHAPTER THIRTEEN: SMART FENCE (cont.)

Not only does the new fence allow the more efficient allocation of scarce resources, it also puts anti-poaching staff one step ahead of rhino poachers, protecting both wildlife and the rangers who put their lives on the line each day.

"With shrinking budgets for conservation efforts, and already limited resources being shifted to address other needs during the COVID-19 pandemic, it is extremely valuable to use technology to make existing operations more efficient. Wildlife ACT is proud to be working with Ezemvelo KZN Wildlife on this groundbreaking initiative in the province, helping to proactively protect not only these key rhino populations but also support the field teams in their work," said Mark Gerrard, Managing Director of Wildlife ACT.

Ezemvelo are upgrading the fence in stages, prioritizing those areas with heavy poaching pressure. HiP has a large wilderness area with no roads, making it difficult for law enforcement to patrol some parts of the park.

Another key technology that anti-poaching teams at HiP are using in conjunction with the Smart Fence is cellular trailcams. These camera traps can detect poachers and automatically send an alert to the Operations Center, allowing rangers to respond rapidly.

On March 6, 2020, one of these infrared cameras detected three armed poaching suspects, and alerted the anti-poaching team to the number of people, the location, and the direction of the infiltration. The suspects were challenged, and the rapid response team was forced to defend itself, resulting in the death of two of the poachers.

In August, South African Environment Minister Barbara Creecy announced that the number of rhinos killed by poachers in South Africa had fallen by more than 50% from the previous year.

However, 166 rhinos were still slaughtered. The reduction is thought to be just temporary relief that was caused by the COVID-19 lockdown, and as the country opens once again, experts warn that rhino poaching may surge once again.

"We realize that as the country opens up, we need to up our game to address the possible threat of poaching," Albi Modise, spokesman for the Department of Environment, Forestry and Fisheries, told the Associated Press.

HiP's Smart Fence is a promising way to redouble anti-poaching efforts in an effort to protect one of Earth's most endangered mammals. This technology is just the first step in creating a "Smart Park" that will be key to combating poaching in HiP.

CHAPTER FOURTEEN: CARBON FOR FORESTS

Global Conservation's Carbon for Forests is the first forest-based carbon offset program which directly funds the protection and restoration of tropical forests, using advanced satellite monitoring combined with ISO-standard monitoring and verification. We do this by enabling the world's top 500 carbon emitters to purchase certified carbon offsets, offering them a direct line to give back and protect the world's wild spaces.

Our planet has lost over 40% of our tropical forests over the past twenty years. Rainforests once covered 14% of the earth's land surface, but now they cover only 6%. Experts estimate that the last remaining rainforests could be consumed in less than 40 years.

How can carbon offsets help save the world's forests? Carbon offset financing aims to reduce the global amount of carbon dioxide in the atmosphere by incentivizing projects that capture carbon from the air and store it. In our case, we are working with reforestation projects, because forests store enormous amounts of carbon and therefore release an enormous amount of carbon when they are burned or cut down. Protecting all existing forests would represent at least 30 percent of the action needed to keep global temperature rise at or below 2 degrees Celsius. Consequently, we use carbon offset financing to reward projects that promote good forest management. It works like this:

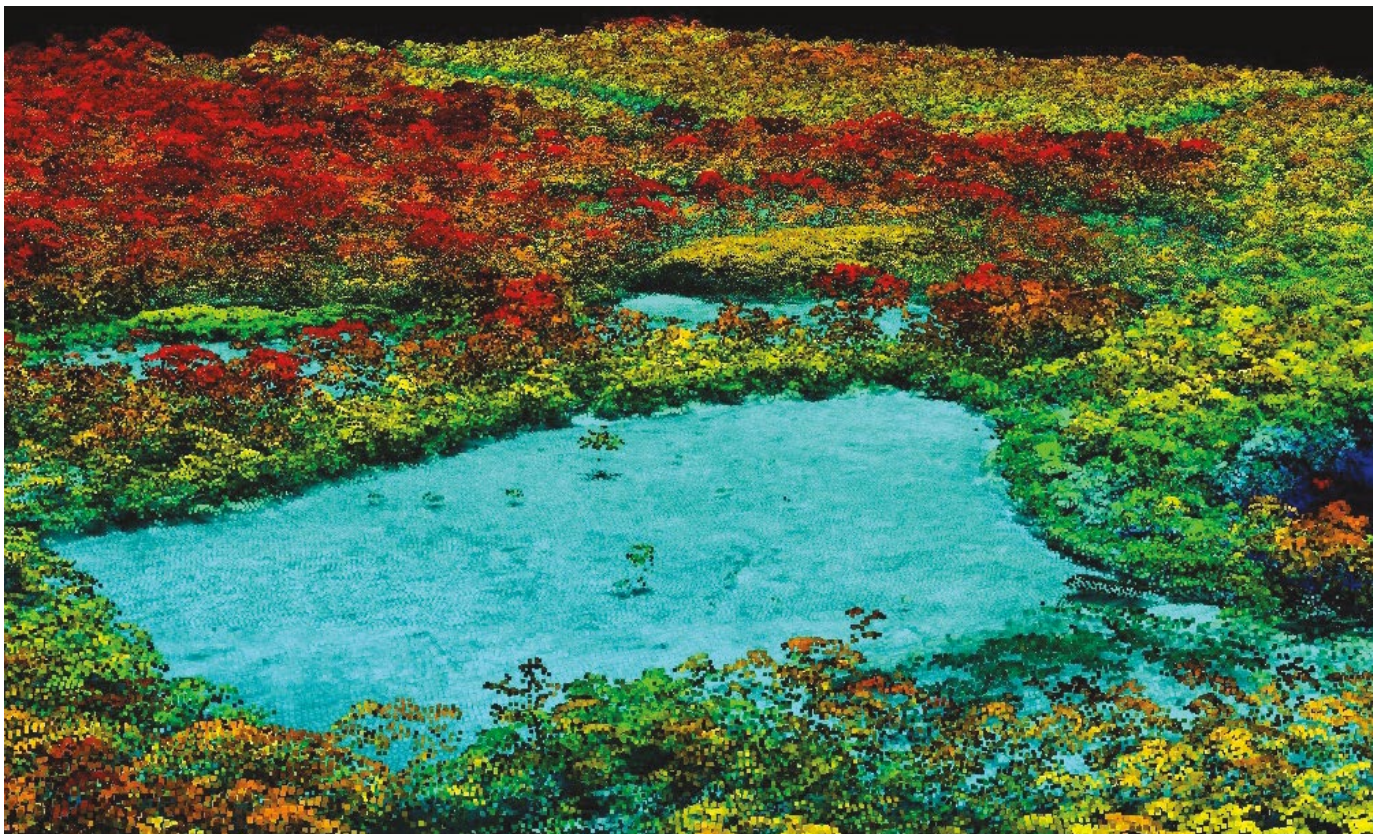
1. An entity, like a corporation (e.g. an oil company), wants to "offset" their carbon emissions by funding projects that capture carbon. They may do this in an effort to reduce their environmental impact or improve corporate social responsibility.

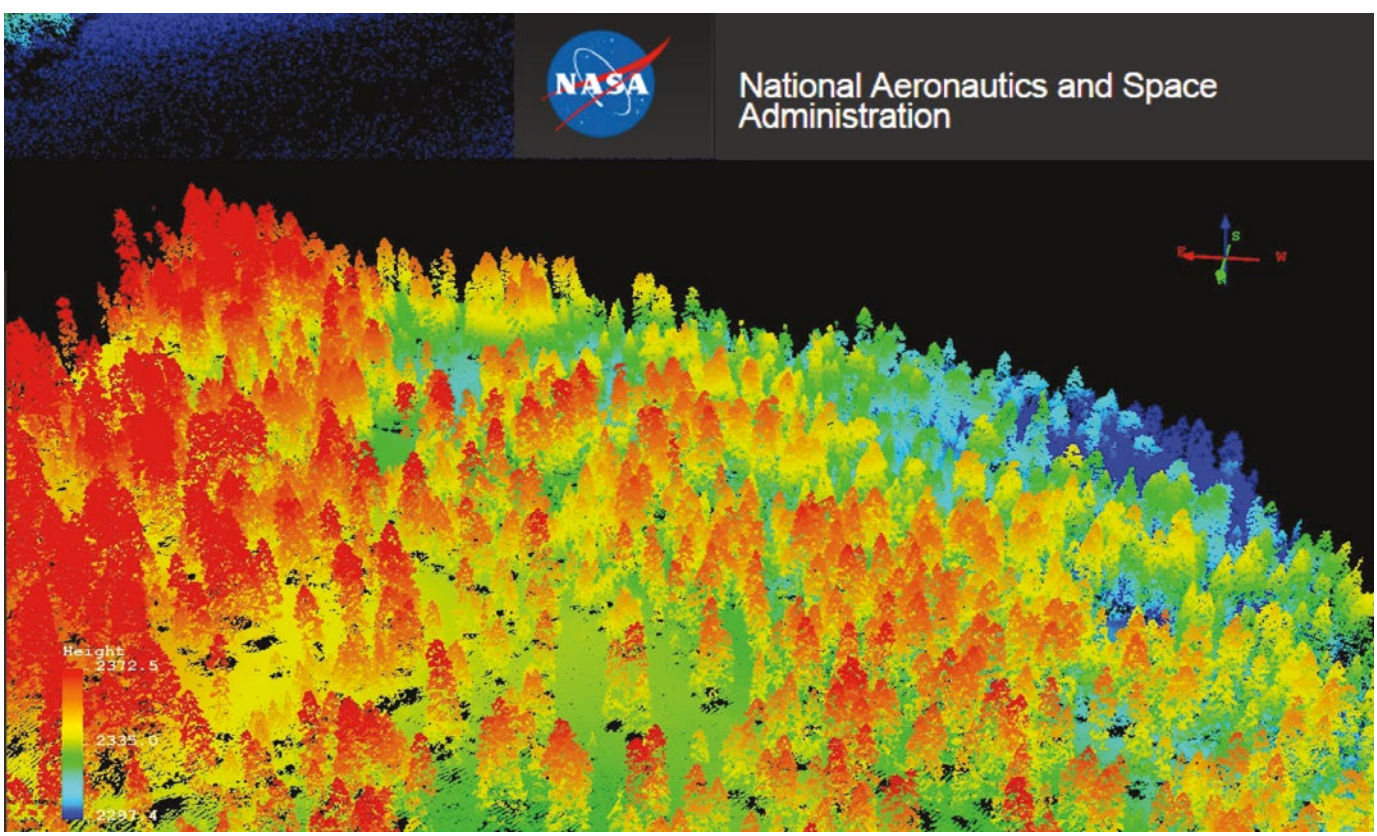
2. The corporation "buys" a given amount of carbon storage, equivalent to the amount to be offset, from a program like Carbon for Forests.

Dr. Greg Asner of Arizona State Univ. reviews LiDAR data to estimate aboveground carbon density (ACD).

3. Carbon for Forests reinvests that money into conservation projects that are successfully capturing carbon. The amount of money each conservation project receives is based on how much carbon it is successfully capturing, indicating how successful its reforestation or forest protection programs are. This is called its "Carbon Offset Value".

4. This results in incentive-based financing for conservation projects while simultaneously combating global climate change.




NASA
National Aeronautics and Space Administration
Height
2372.5

CHAPTER FOURTEEN: CARBON FOR FORESTS (cont.)

Working with Nature Needs Half, Carbon for Forests is targeting UNESCO World Heritage Sites and national parks in developing countries with the highest rates of deforestation. By comparing national and regional deforestation rates with gains and losses of forest coverage achieved through protection and reforestation programs, Carbon for Forests is able to accurately estimate the Carbon Offset Value (and changes) of each 1-million-acre (405,000-hectare) forest block for monitoring and verification. There are over 100 UNESCO World Heritage Sites and national parks in high-deforestation countries that will be suitable for Carbon for Forests funding.

Carbon for Forests signs 20-year carbon offset contracts with Large Carbon Emitters (LCEs), such as oil companies. The financing from these contracts guarantees forest protection and reforestation goals in each national park. Annual payments are made in exchange for performance in park protection and reforestation. If there are unexpected gains or losses in forest coverage and carbon values, annual payments are adjusted accordingly.

The greatest challenge is accurately measuring the amount of carbon stored in an ecosystem in order to track a project's performance and determine its Carbon Offset Value. To do this, Global Conservation is partnering with the Arizona State University Center for Global Discovery and Conservation Science (ASU GDCS) to use 3D laser (LiDAR) and multi-spectral analysis for carbon value verification. LiDAR provides detailed three-dimensional information of the forest canopy height and structure over large areas. However there is a cost-based limit to the scale of LiDAR measurements. To overcome this, GDCS combines its LiDAR data with satellite images to map forest carbon across millions of hectares. GDCS's method allows us to monitor carbon in forests with the highest level of detail.

"Our [work] powerfully demonstrates a new capability to not only measure forest carbon stocks from space, but far more critically, to monitor changes in carbon emissions generated by a huge range of activities in forests," said Greg Asner, director of ASU GDCS. *"The days of mapping forests based simply on standing carbon stocks are behind us now. We are focused on carbon emissions, and that's precisely what is needed to mitigate biodiversity loss and climate change."*

A critical baseline is calculated at the start of each Carbon Offset Contract, with quarterly assessments on progress. All reporting is available 24-7 through an online Carbon for Forests portal. Each year, a review of progress is sent to each investor showing in detail an inventory of all gains and losses in forest coverage and carbon offset values. Based on performance, annual payments are adjusted to reflect decreases/increases in the carbon offset value of the forest protection and reforestation efforts.

Protecting half a million hectares of tropical forest prevents almost 450 million tons of carbon dioxide from escaping into the atmosphere at a cost of only US$650-900,000 per year, or approximately $13-18 million over 20 years.

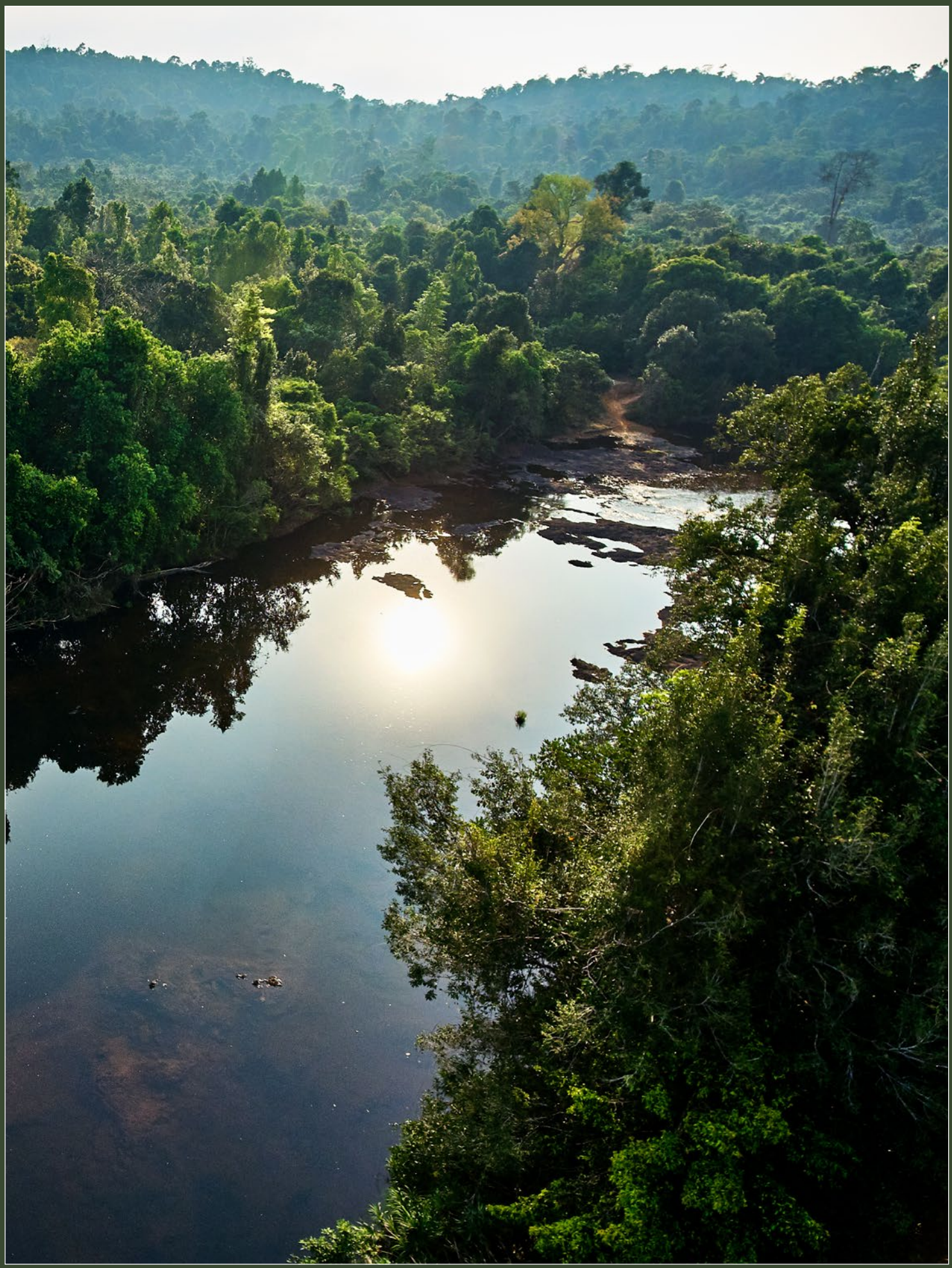
Carbon offset financing enables multi-year funding of Global Park Defense for on-the-ground protection of forests and wildlife habitats. Once funding is secured, Global Conservation and our partners support national park authorities to implement Global Park Defense using advanced protection systems, technology, communications and training to achieve "No Cut, No Kill" protection. Our primary goal is to eliminate illegal logging and land clearing, and to reforest destroyed or degraded areas to improve forest coverage and carbon values.

CHAPTER FOURTEEN: CARBON FOR FORESTS (cont.)

Why Carbon for Forests?

- Protects large intact forests and funds reforestation for damaged forests in and around national parks over 25 years. Carbon offsets include both avoided deforestation and reforestation
- Directly funds park protection, monitoring and enforcement using Global Park Defense methodology
- Reduces CO2 emissions from forest fires due to land clearing and illegal development
- Offers a global portfolio of intact forests for carbon offsets to align with corporate social responsibility
- Generates growth and employment through sustainable tourism to UNESCO World Heritage Sites and national parks, including new infrastructure, roads and community services
- Builds capacity in developing countries for park and forest protection, sustainable tourism and resource management
- ISO-standard verification and monitoring based on advanced satellite monitoring and science-based forest and carbon offset accounting
- Insured for performance against catastrophic forest losses

This photo of the Leuser Ecosystem by Paul Hilton demonstrates the need to reduce CO2 emissions from the illegal burning of tropical forests.

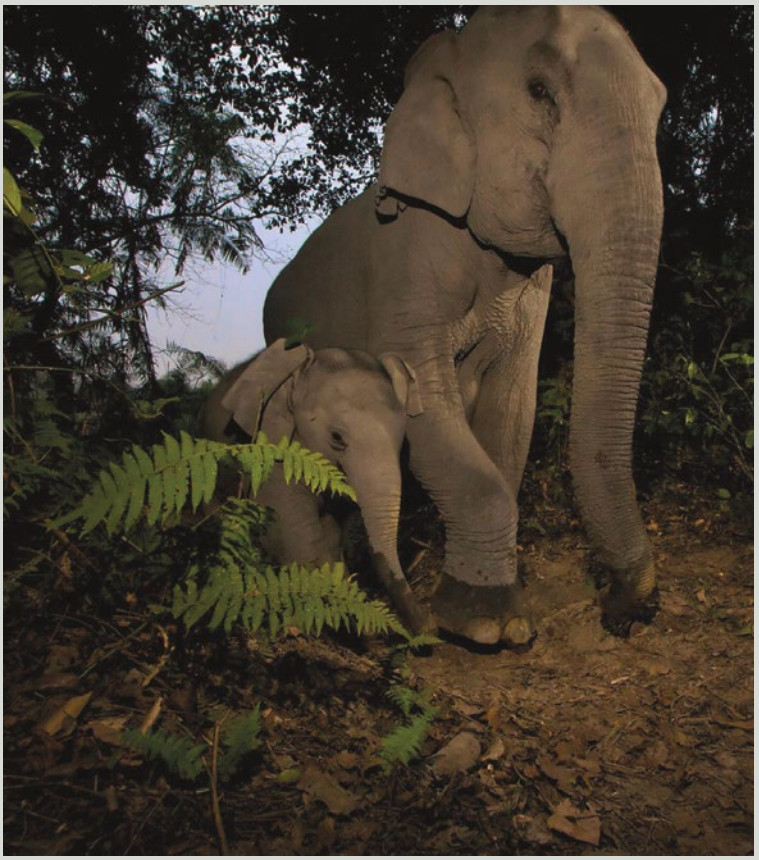


Case Study: Carbon for Forests in Cardamom

In a country like Cambodia, which has faced 20-30% deforestation nationwide over the past 10 years, large-scale forest protection in national parks will be the most direct and effective way to protect the country's 3.1 million hectares of critical forest ecosystems.

Cambodia has one of the highest rates of deforestation in the world, third only to Nigeria and Vietnam, according to the United Nations Food and Agriculture Organization (FAO). The Cambodian government has played a large role in shaping the use of the country's forests.

Deforestation has directly resulted from poorly managed commercial logging, wood collection for fuel, agricultural invasion, and infrastructure and urban development. Indirect pressures include rapid population growth, inequalities in land tenure, lack of agricultural technology, and limited employment opportunities.



Cambodia's primary forest cover fell dramatically from over 70% in 1970 at the end of the Vietnam War to just 3.1% in 2007. Deforestation is proceeding at an alarming rate, with a total forest loss of nearly 75% since the late 1990s.

In total, Cambodia lost 2.5 million hectares of forest between 1990 and 2005, 334,000 ha of which was primary forest. As of 2007, less than 322,000 ha of primary forest remain, so the future sustainability of Cambodia's forest reserves is under severe threat.

CHAPTER FOURTEEN: CARBON FOR FORESTS (cont.)

Cardamom National Park was established in 2015 and is in dire need of international financial support in order to save one of Cambodia's last intact tropical forests. Covering almost a million hectares, Cardamom National Park is protected by Wildlife Alliance in partnership with the Ministries of Environment and Forestry.

With Carbon Offset Financing, there is a high potential for the entire Cardamom Mountains to be protected, securing clean water, ecosystem services, tourism revenues and better livelihoods for millions of Cambodians.

SPOTLIGHT: MILITARY STAFFING IN CARDAMOM NATIONAL PARK

In Cardamom National Park, Cambodia, our partners at Wildlife Alliance have taken a different approach to staffing their law enforcement teams. Wildlife Alliance hires military-trained foreign nationals from countries like Ukraine and Romania to lead teams of 30-40 local rangers. Though the cost to employ them is higher, their expertise is invaluable and their experience and leadership helps to build local capacity. Further, because they are not entangled in local sociopolitical structures, they tend to be less corruptible.

CHAPTER FIFTEEN: UNMANNED AERIAL VEHICLES (Drones)

Over the last decade, unmanned aerial vehicles (UAVs), also called drones, have become one of the most important pieces of technology in conservationists' toolkits. They have a wide range of applications, from wildlife monitoring to tracking poachers.

Consumer drones first hit the market around 10 years ago, but the industry only took off with the launch of DJI's Phantom 4 and Mavic Pro in 2016. Consumer drones have quickly dropped in price and risen in quality since then.

Drones are often considered to be an excellent alternative to light aircraft, which have been a historically important tool in conservation. However, light aircraft have serious limitations: they're very expensive and they're dangerous. In fact, light aircraft are the number one killer of wildlife biologists on the job, killing 60 biologists and other scientists in the field between 1937 and 2000. In that same time, 31 scientists died on the job from all other causes combined.

Aside from this, drones have several advantages over human pilots or biologists on foot: they can be operational nearly at all times, are unhindered by heavy forest cover, and of course, do not need to eat or sleep.

The two main types of drones on the market are fixed-wing, which look like airplanes, and rotary-wing, which have rotating blades like helicopters. Fixed-wing drones are used in situations that require speed or long distances, as they can fly farther and faster on a single battery than a rotary-wing drone. Rotary-wing drones, on the other hand, are able to fly at very slow speeds, and can even hover in place, an impossibility for a fixed-wing drone. Both types can carry cameras or sensors to collect data or images, or even live-stream video back to the user.

Drones can be equipped with a wide range of cameras and sensors, such as high-resolution still photo cameras, video cameras, multispectral sensors, thermal cameras, LiDAR or other laser

Drones allowed scientists to conduct population surveys on a newly-discovered supercolony of 1.5 million Adélie penguins.

scanners, and instruments to measure temperature, humidity, or air pollution. Larger drones can lift sampling equipment, cargo, or emergency supplies.

See page __ for an account of how scientists are using drones to count orangutan nests in the Leuser Ecosystem of Sumatra.

Here are a few other ways that drones are being used by conservationists today:

1. U.S. National Park Service rangers in the Grand Canyon, USA, are using drones to search for missing hikers.

2. Scientists used drones to count a newly discovered supercolony of 1.5 million Adélie penguins, after it was found using satellite imagery.

3. African Parks rangers in Malawi are testing the use of thermal cameras to detect and deter poachers entering Liwonde National Park at night.

4. The Amazon Basin Conservation Association is using fixed-wing drones in Peru to quickly investigate reports of deforestation in a vast, dense rainforest reserve with no paved roads.

5. Australian rangers are using drones at sea turtle nesting sites to monitor beaches for the tracks of feral pigs, which are nest predators. When they're found, rangers deploy to cull the invasive pigs. They can also use the aerial view of the turtles' tracks in the sand to determine which species of turtle are nesting on a given beach, and the total number of nests there.

6. Scientists at Liverpool John Moores University in the UK are using thermal images captured by drones to identify and count wildlife on a landscape scale. At night or in dense vegetation, thermal cameras show animals as bright glowing spots against a dark background, like stars in the night sky, so these scientists are using methods from astronomy to automatically count and classify the wildlife.

They are also commonly used to count wildlife, map habitats, observe the behaviors of large species like whales, monitor alien plant invasions, check on the condition of infrastructure like fences, and map burn scars or erosion.

As technology continues to improve and drone price continues to drop, conservationists will undoubtedly find an increasing number of uses for this versatile technology.

Tech 2.0: The Future of Global Park Defense

At Global Conservation, we are always looking to the future and staying current in the ever-changing technological aspects of conservation. Being based in the Silicon Valley puts us at the forefront of technological development and advancements. We work to adapt new, advanced technologies to protect the world's wild spaces.

CHAPTER SIXTEEN: STARLINK

We are eagerly anticipating the launch of SpaceX's Starlink, a satellite-based, broadband internet system. With Starlink, SpaceX aims to provide near-global internet service by late 2021 or 2022. Widely available internet access will be a huge boon for parks in remote areas that frequently suffer from a lack of communications infrastructure, often including a lack of basic cell coverage.

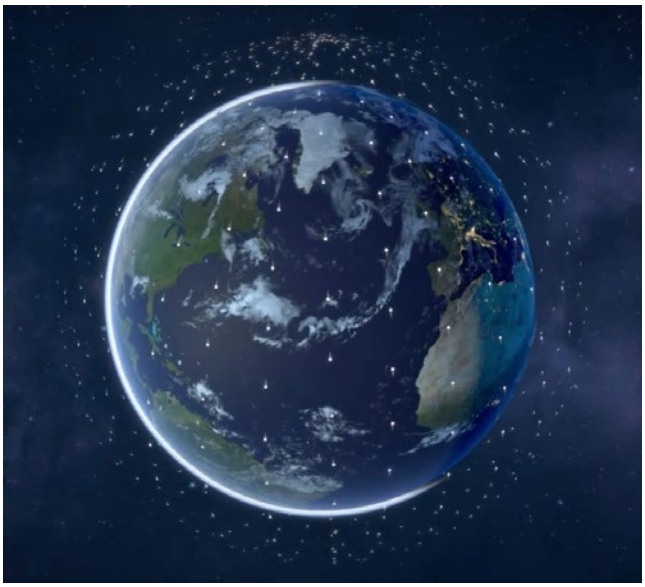
With access to the internet, park authorities can more easily stay in touch with each other and with colleagues outside the park, and have greater access to resources such as online information and training opportunities. It will also become easier to deploy better park and wildlife protection systems, like cellular trailcam surveillance and cloud-based protection systems.

Commercial operation could begin in 2020, but will not likely reach many countries in Africa, Latin America and Asia for years to come. Global Conservation will begin testing the Starlink system next year with 5G Cellular Trailcams.

The ability to connect low-cost Cellular Trailcams and other sensors to a satellite-based network would open incredible opportunities for park authorities to expand protection across large areas without investing in expensive cellular or digital radio towers and infrastructure.

SpaceX's billionaire founder and CEO Elon Musk has approval to launch about 12,000 Starlink satellites and has applied for permission to loft up to 30,000 more. SpaceX needs about 400 Starlink craft to provide "minor" coverage and 800 for "moderate" coverage, Musk said last year.

As of September 2020, the company has launched 715 satellites into orbit. A number of additional such launches will be required before



With global cell coverage by Starlink, we will be able to deploy Global Park Defense to more locations.

Starlink can beam data for the rest of us, including many "dark parks" in developing countries with no cellular service.

SpaceX isn't the only company with internet-satellite plans. Amazon aims to launch more than 3,000 broadband craft of its own, and OneWeb launched the first six satellites of a 650-strong constellation earlier this year. The total cost of the decade-long project to design, build and deploy the constellation was estimated by SpaceX in May 2018 to be about US$10 billion.

SpaceX has revealed key details about the planned constellation's abilities, stating that the satellites have shown "super low latency and download speeds greater than 100 mbps." Users will tap into the constellation using personal antennas on the ground. SpaceX CEO Elon Musk has described them as looking like a "UFO on a stick."

By taking advantage of technical advances like Starlink, Global Park Defense will remain on the cutting edge and provide the most efficient protection for the world's wildlands.

CHAPTER SEVENTEEN: TRAILGUARD AI

TrailGuard AI is a revolutionary next-generation cellular trail camera that will help protect against human-wildlife conflict and illegal activities like poaching and logging. Created by the environmental organization RESOLVE and software developer CVEDIA, TrailGuard is a very small camera embedded with a processing chip that automatically detects and alerts managers to people, vehicles, and wildlife.

The TrailGuard revolutionizes trail cameras in several ways. Firstly, its on-board artificial intelligence can be trained to recognize people, vehicles like logging trucks, and specific wildlife species without an internet connection. When triggered, the AI system captures four images, which are analyzed and stored on the SD card. Images containing positively identified people, vehicles, or wildlife will be sent as an alert in near-real-time to a designated cell phone or computer via 2G mobile networks or as a radio signal. While 75% of images from standard trail cameras are false triggers, the TrailGuard AI is able to filter out irrelevant images, eliminating false alarms and extending battery life.

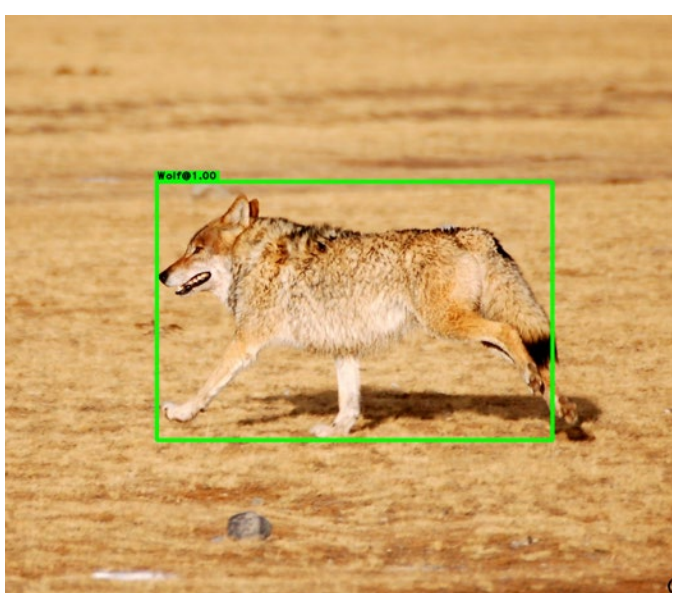
RESOLVE and CVEDIA are now working to train the AI to detect intruders in uniforms, to identify the weapons they carry, and even re-identify suspects for use in prosecution. The more information, the better – detailed intel can help save rangers' lives, as they can better prepare when intercepting criminals. Advance warning technology like TrailGuard can help prevent tragedies such as the April 2020 attack in Virunga National Park, DRC, where 13 rangers were killed in an ambush.

The second benefit of TrailGuard is that it is incredibly small – the head of the camera, along with the passive infrared sensor, is only about the size of a person's index finger. It is attached by a cable to the battery box and communications

unit. That way, when the camera head is mounted and surrounded with a little bit of bark or elephant dung, it becomes virtually invisible. The battery box can then be completely hidden, and the cable is designed to look like a vine. To assist even further in its concealment, the camera has a narrower field of view and faster wake-up time than traditional trail cameras, allowing it to be mounted farther away (3-5m) from the trail that is being monitored.

Further, with its military-grade AI, TrailGuard can accurately detect humans regardless of the angle of the sensor to the trail. This means that

CHAPTER SEVENTEEN: TRAILGUARD AI (cont.)



cameras can be placed high in a tree, or even directly over a trail, enhancing concealment (and connectivity). Keeping trail cameras well-hidden is crucial for preventing criminals from avoiding them, as well as protecting the cameras from vandals or thieves.

Thirdly, the TrailGuard can operate for 1.5 years on a single rechargeable battery, rather than two months like most other trail cameras. This avoids calling attention to the location of the camera trap when managers have to change batteries, and reduces the amount of time needed for camera maintenance.

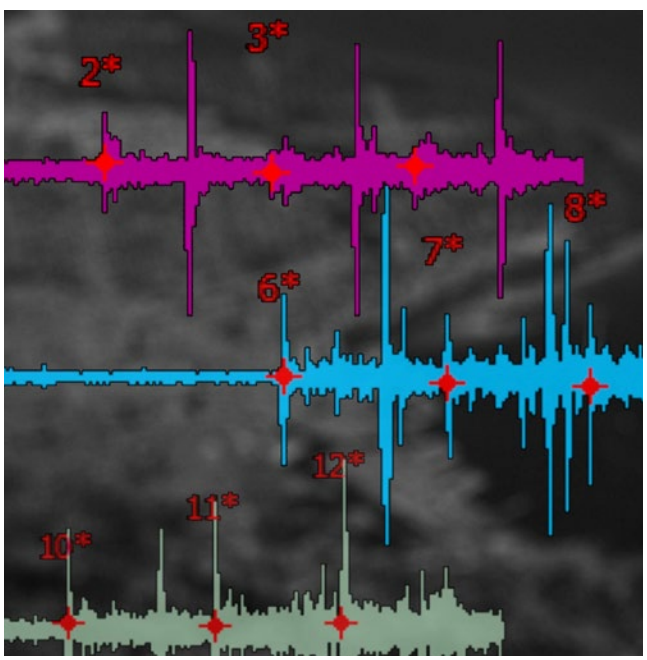
In the Himalaya, TrailGuard is currently being used with a species recognition AI, called WildEyes AI, to detect snow leopards, Tibetan wolves, and brown bears that prey on livestock. When one of these predators is detected, speakers and strobe lights can be triggered to frighten them off before they can kill livestock or endanger villagers. These systems not only protect the livelihoods of Himalayan communities, but also protect these threatened predators from retaliation.

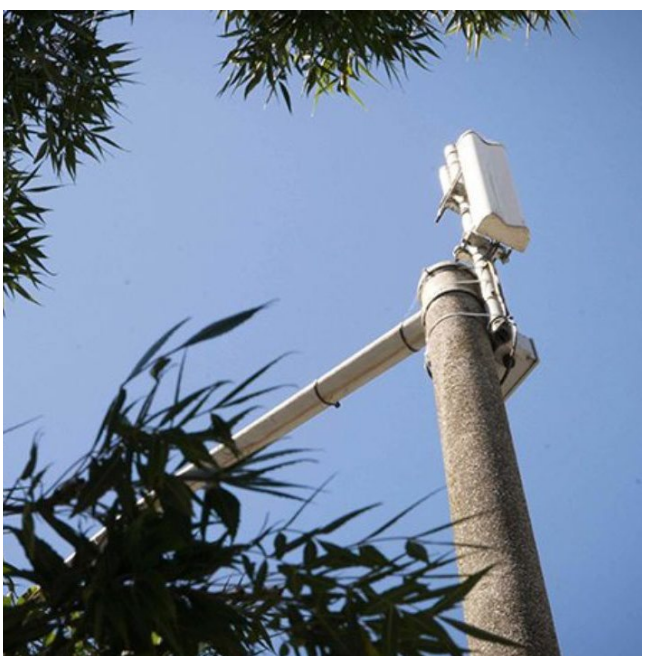
WildEyes is also guarding communities in Thailand from elephants, which enter villages to raid crops and can occasionally kill villagers. The elephants are often killed in retaliation. Human-elephant conflict is common wherever elephants occur; they cause over US$10 million in crop and property damage each year in Sri Lanka, and damaged $600,000 worth of crops in Tanzania in 2019. TrailGuard could potentially replace more expensive and time-consuming methods that are being used currently, like building fences or radio-collaring animals.

Once commercially available, TrailGuard with WildEyes AI will start at $450 but will eventually become cheaper.

CHAPTER EIGHTEEN: SHOTSPOTTER

ShotSpotter is gunshot detection technology that uses acoustic sensors, placed strategically in high-crime areas, to alert law enforcement in real-time to the location of gunshots. Although ShotSpotter was developed to detect gunshots in cities, the company has recently launched two environmental initiatives to apply the technology to fighting rhino poaching and blast fishing.





CHAPTER EIGHTEEN: SHOTSPOTTER (cont.)

Blast fishing is the practice of bombing reefs, for example with grenades or dynamite, to kill a large number of fish at once. It is a widespread issue in Southeast Asia, Central America, and East Africa. While this method is more efficient at killing large numbers of fish than netting or spearing, it causes severe damage to the underlying reefs. This can reduce a healthy reef to a barren wasteland that may take decades to recover, if ever.

The short-sighted practice threatens tourism industries, which are often centered around scuba diving in tropical reefs, and is destructive to local fisher livelihoods. These blasts can remove hundreds of pounds of fish from an area during just a week-long fishing trip, and destroy the habitat that would allow fish stocks to recover. The bombs are indiscriminate, killing fish that haven't yet reached sexual maturity as well as species like turtles that are not normally caught. Once the reef is destroyed, fishermen must look for alternative livelihoods or travel further for fish.

In the vast expanse of the ocean, this is a difficult crime to stop. Very little of the sound of the blast is transmitted above water; most is trapped below, making blast fishing difficult to detect in the first place. Even when law enforcement is aware that blast fishing has occurred, they may not be able to pinpoint the location. That makes it very difficult to apprehend the criminals, and even when they are arrested, it is challenging to prove in court that they are guilty. Convictions are rare.

Consequently, the organization Stop Fish Bombing has adapted ShotSpotter to combat blast fishing in Sabah, Malaysia. With ShotSpotter, underwater sensors (hydrophones) can detect a blast and triangulate its location to within 20-50m, sending an alert to law enforcement in

Hydrophones and ShotSpotter technology can detect underwater blast fishing for fast response by rangers.

seconds. Marine rangers can then interdict the criminals, and they have the acoustic evidence to convict them. With ShotSpotter, law enforcement in tropical countries can better protect the reefs that attract millions of tourists each year and provide US$172-375 billion annually in goods and services worldwide.

In Kruger National Park, South Africa, ShotSpotter is being deployed to combat rhino poaching. Unfortunately, rhino poaching often goes undetected until a carcass is found days or weeks later. ShotSpotter, on the other hand, can alert rangers to a gunshot within 60 seconds, directing them to the exact location. Their response is fast and accurate, which increases the chances of arresting poachers and acts as a deterrent to future crime. ShotSpotter also plans to integrate its technology with drones, which will immediately dispatch to the crime scene and provide rangers with a live video feed that can help them track poachers.

CHAPTER NINETEEN: THAP LAN NATIONAL PARK

Achieving "No Cut, No Kill"

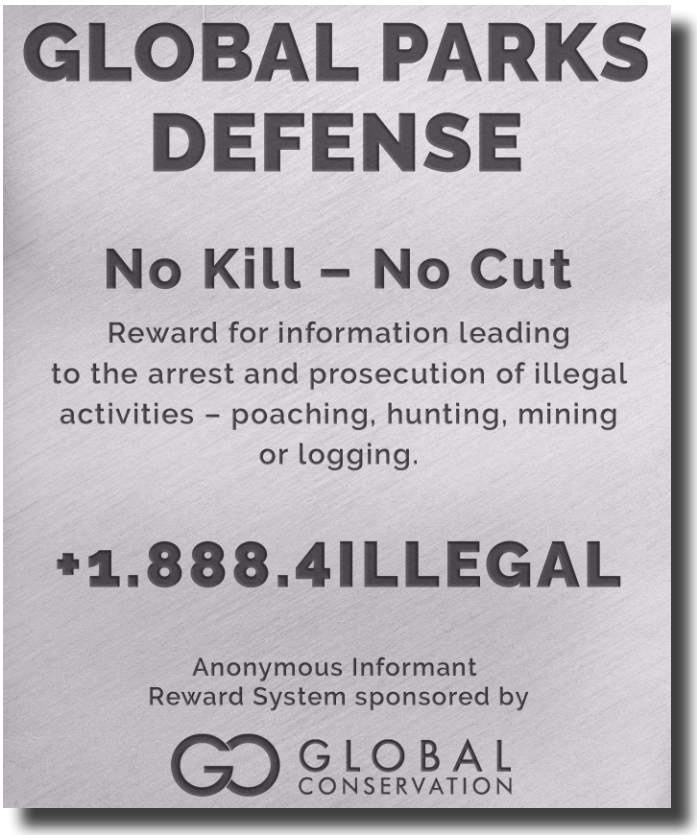
Thap Lan National Park is the epicenter of Thailand's Rosewood Wars. Hundreds of illegal loggers and their crews are cutting the last Siamese rosewood trees, one of which can be worth US$4,000-6,000, and killing the rangers who try to stop them. Those deaths and rosewoods' red-hued timber have led conservationists to call it "bloodwood."

Protecting Thap Lan from this onslaught is crucial. Thap Lan is Thailand's second largest park and one of the last intact habitats for a suite of threatened and endangered species: elephants, Asiatic bears, clouded leopards, banteng, gaur, sambar, malayan sun bears, hornbills, and over 800 other vertebrate species. Thap Lan is at the heart of the DPKY, a 595,700 hectare cluster of five contiguous national parks and a globally important biodiversity hotspot. This area contains the last substantial piece of Southeastern Indochina dry evergreen forest in the world.

CHAPTER NINETEEN: THAP LAN NATIONAL PARK (cont.)

In July 2015, the Rosewood Wars, a lack of law enforcement, and a proposal to build a highway through the DPKY caused the UNESCO World Heritage Committee to threaten to downgrade the DPKY to the World Heritage in Danger list. The transnational crime syndicates that run these logging operations have long enjoyed an advantage over park rangers because of superior numbers, funding and weaponry. That equation changed in 2016 with the deployment of Global Park Defense systems, technology and training. By 2018, we had achieved our 500th arrest of illegal loggers in Thap Lan National Park – a clear indication of both the degree of threat to this unique place and the effectiveness of Global Park Defense.

The multi-year deployment of Global Park Defense includes training for rangers on night patrolling, park protection systems, armed combat, and improving patrol effectiveness. Focused on breaking up the Thai syndicates, middle men, and the supply chain providing illegal teams with chainsaws and supplies, Global Park Defense technology gives Thap Lan Park Rangers a "force multiplier" by targeting patrols and improving park-wide protection.



Global Park Defense plaques are attached on or near official park signage on the entire park border.

Finally, an anonymous informant reward system helps eliminate corruption by park officials. Global Park Defense plaques are attached on or near official park signage on the entire park border with a toll-free number to report illegal activities. An independent 24/7 call center logs and reports all legitimate calls which are professionally reviewed and dispatched. Internet teams of current and former law enforcement officers, along with wildlife crime experts, inspect reports before forwarding to park authorities and law enforcement officers. The reward system offers up to US$1,000 for anonymous informants resulting in a successful prosecution, and up to $200 for a successful arrest.

Over the past five years, we have worked with our partners to achieve these conservation outcomes:

CHAPTER NINETEEN: THAP LAN NATIONAL PARK (cont.)

- Reduced illegal activities and encroachment
- Introduced sustainable tourism for increased park revenues and government and public recognition
- Strengthened the SMART patrol system
- Restored the Lum Prang Ranger Station in the core of the park to full function
- Restored key wildlife habitats to allow recovery of tigers, elephants, and other large wildlife, and provided viewing areas for visitors
- Tripled the number of rangers, provided them with military support, and increased park operations and capital investment available by 3-4 times
- Provided supplies, GPSs, digital cameras, high quality uniforms, field gear, and other necessary supplies to improve the morale of park rangers and patrol effectiveness
- Installed and improved the SMART Patrol Center for Thap Lan National Park to be used as a place for monthly patrol meetings among park officers and rangers

- Provided rewards for park rangers for important arrest cases
- Provided rewards for informants who give intelligence information to help enforcement
- Installed a park-wide radio communications system for rangers and sensors/camera traps
- Implemented hidden cellular camera traps on trails to detect movement of rosewood and wildlife poachers; real-time photos alerted park rangers for timely interdiction
- Implemented seismic sensors to detect illegal pedestrian or motor vehicle activities in and around the park
- Began flying UAVs (drones) regularly across the entire park border and sensitive areas to monitor encroachment and to detect poaching and logging camps
- Installed a command and control system using GIS and LANDSAT 8 data analysis, integrating patrol communications and dispatch systems
- Began scientific monitoring of wildlife populations using transect patrolling and camera traps to count tigers, leopards, bears and other wildlife every year

CHAPTER TWENTY: MIRADOR NATIONAL PARK

Building Ranger Teams with Local Communities

At El Mirador, the Maya built the most voluminous pyramid in the world, called La Danta. At 2.8 million cubic meters (more than 1,100 Olympic swimming pools), 70 meters high, and with a base the size of 35 football fields, it took up to an estimated 15 million man days of labor to construct. But in addition to its cultural treasures, this part of Guatemala is also biologically rich.

The Mirador ecosystem contains six kinds of tropical forest, 300 tree species, 200 animal species, and five of the six cats indigenous to Central America. Large populations of elusive jaguar and threatened white-lipped peccary live here, alongside pumas, tapirs, ocelots, agoutis, brocket deer, and rare harpy eagles. Mirador's southern limestone cliffs are the last place in the world with viable populations of the orange-breasted falcon. Mirador is also on a critical flyway for birds migrating from central and eastern North America.

The La Danta pyramid is one of many significant cultural treasures within the park boundaries.

CHAPTER TWENTY: MIRADOR NATIONAL PARK (cont.)

The ancient city of El Mirador has been partially protected since 1990 by the small Mirador-Río Azul National Park, part of the Maya Biosphere Reserve, more than 2 million hectares of rainforest in northern Guatemala. Although the Maya Biosphere Reserve covers an impressive 10% of Guatemala's total land area, almost 50,000 hectares of forest are lost each year in this reserve to agriculture and cattle ranching. In just the past 10 years, more than 60% of the Maya Biosphere Reserve's forests have been destroyed.

To fight these threats, Global Conservation has deployed a Global Park Defense system including cellular trailcam networks, facial recognition software, command and control systems, satellite monitoring, and community involvement.

Global Conservation has also collaborated with our partners FundaEco, Rainforest Trust, and FARES to establish the first Mirador Park Authority. FundaEco spent three years training this special team of rangers, who carry out patrols with the army and the police and permanently patrol the entire area. They work together to stop wildlife poaching, looting of archaeological sites, illegal logging, and land clearing for cattle ranching. Their patrols now cover 40 ancient Maya cities and over 300,000 hectares of tropical rainforests.

Mirador Park rangers have now been trained in:

1. The SMART Patrol system
2. Protected areas management
3. Fighting forest fires
4. Biological monitoring
5. First aid
6. Garmin InReach GPS system
7. Self defense
8. Trail and camp maintenance
9. Visitor safety and security
10. Assisting community tourism cooperatives

Another important component of protecting Mirador is the Community Eco-Guard program. Community Eco-Guards play a critical role assisting park rangers and community tourism cooperatives, and monitoring trails and roads using SMART ranger patrols and surveillance systems. Twelve Community Eco-Guards will be selected from the gateway communities of Mirador – Carmelita and San Andres – to assist Mirador Park Ranger teams and police in undertaking key protection and conservation activities, including:

- Park monitoring and surveillance
- Trail and camp maintenance
- Visitor safety and security
- Communications with rangers and law enforcement
- Assisting NGOs in wildlife conservation
- Assisting community tourism cooperatives

CHAPTER TWENTY: MIRADOR NATIONAL PARK (cont.)

Community Eco-Guards are an important complement to the park ranger teams. Firstly, Eco-Guards allow us to increase the size of patrol teams without the sometimes bureaucratic and expensive process of hiring new rangers. Secondly, because they are local people who know the forest well, we can capitalize on their knowledge. Thirdly, Eco-Guard programs allow us to recruit young people to complement more experienced rangers, creating a de facto training program for recruiting new rangers.

Finally, this program offers local residents, who might otherwise make a living hunting or logging, an alternative livelihood. Over time, former wildlife poachers, loggers, and looters will be selected from the Community Eco-Guards and trained to become full-time rangers.

2021 will be our final year of a five-year GPD program. Our long-term goal in Mirador is to achieve "No Cut, No Kill" protection while increasing tourism revenues to benefit local communities. We also aim to achieve UNESCO World Heritage Designation for Mirador, and to expand the area of the park by purchasing neighboring forestry concessions.

Spotlight: Francisco Asturias

These efforts are being led by Francisco Asturias, Director of FundaEco and the Mirador Park Rangers. In the past two years, Asturias and his team have achieved the following:

Mirador Patrols: Over 42,871 km patrolled in the past 18 months (average of 2,382 km per month).

International Patrols: In collaboration with Mexican authorities, Mirador Rangers and Eco-Guards patrolled with Guatemalan Army and Police, closing down a major illegal logging syndicate working inside Mirador National Park.

Arrests and Citations: 62 crimes have been identified and arrests made in 52 cases over the 12 months. Twenty-two loggers were captured, and their equipment and a truck were seized.

Ranger Training: Both on-the-job and classroom training was conducted. Further, two Mirador rangers attended a two-week park management training at Colorado State University.

CHAPTER TWENTY-ONE: LEUSER ECOSYSTEM

Using Drones for Forest Monitoring

There's just one place left on earth where tigers, elephants, orangutans, and rhinos live together in the wild: the Leuser Ecosystem World Heritage Site on the Indonesian island of Sumatra.

One of the last remaining intact rainforests in all of Indonesia, the Leuser Ecosystem spans 2.6 million hectares, including lowland and montane rainforests, wetlands, and over 185,000 hectares of carbon-rich peatlands. It is a crucial source of clean drinking water and agricultural livelihoods for over four million people. In fact, the ecosystem services provided by the Leuser Ecosystem, including 1.6 billion tons of carbon and the provision of water to 4 million people, are valued at over US$600 million annually.

High profile activists Leonardo DiCaprio, Farwiza Farhan and Adrien Brody in the Leuser Ecosystem.

CHAPTER TWENTY-ONE: LEUSER ECOSYSTEM (cont.)

However, Leuser is highly endangered, with threats accelerating since the end of the Acehnese rebellion and civil war. Post-war stability is bringing rapid invasion of commercial interests in palm oil, rubber, and logging, with companies legally and illegally deforesting the Leuser Ecosystem at astounding rates. Between 1985 and 2009, half of Sumatra's forests were destroyed. The decimation continues today; despite its protected status, Leuser has lost one-fifth of its lowland forests to illegal commercial activities in just the past five years. At that rate, the forest will be completely destroyed within two decades.

CHAPTER TWENTY-ONE: LEUSER ECOSYSTEM (cont.)

The primary threat to this unique ecosystem is illegal palm oil expansion. As global demand for palm oil rises, oil palm growers seek to multiply the acreage of this valuable crop. Unfortunately, there is little unoccupied land left in Indonesia, leading growers to encroach illegally into the country's dwindling but exceptionally biodiverse protected areas.

In addition to palm oil, it faces accelerating threats by illegal and commercial interests in logging, mining, ill-advised energy projects, and the fragmentation of forests by new roads. The fires from this widespread destruction have caused major haze pollution from Singapore to Jakarta, resulting in huge economic losses and public health issues.

Due to this destruction, Sumatra's unique megafauna species are in serious danger. Of the world's 80 remaining wild Sumatran rhinos, Leuser contains 50—the last viable population of this species on Earth. Of just 400 remaining Sumatran tigers, more than 100 live in Leuser, which is one of only two regions with enough breeding females to sustain this subspecies.

Finally, 85% of the world's critically endangered Sumatran orangutans call this forest home. As Sumatra's forests disappear, it seems increasingly likely that Sumatran orangutans will become the first great ape to go extinct. All of this has led conservationists to call Leuser one of the "world's most irreplaceable protected areas" – if this forest disappears, these species will go with it.

Global Conservation has funded the acquisition and deployment of advanced mapping UAVs/drones to document illegal deforestation within and around the Leuser Ecosystem. Both fixed-wing long-distance drones and quadcopters are being used to uncover large-scale rainforest destruction for illegal palm oil plantations within the Gunung Leuser National Park and Greater Leuser Ecosystem.

Because they allow the Leuser team to see large areas of forests far from access roads, drones are proving invaluable in the fight to get government, community leaders and law enforcement to stop forest and wildlife habitat destruction.

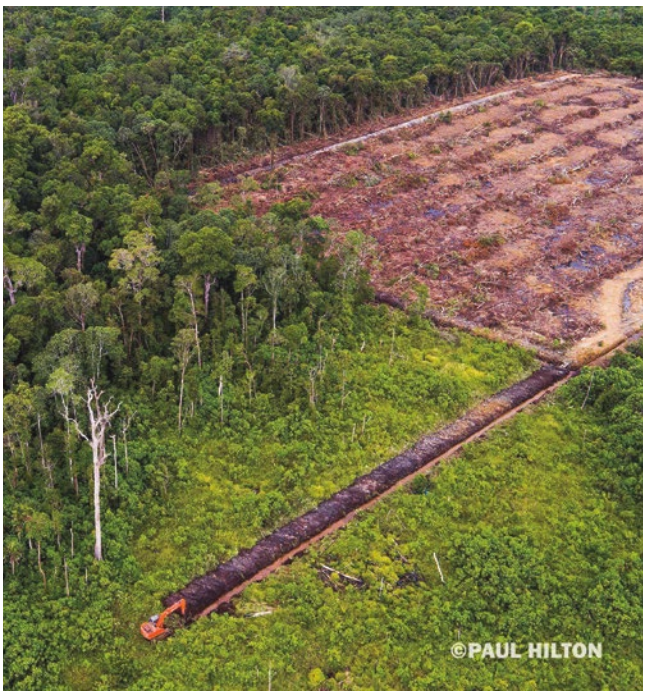
CHAPTER TWENTY-ONE: LEUSER ECOSYSTEM (cont.)

Drones are relatively cheap, can cover hundreds or even thousands of hectares in a short space of time, and can beam back live video transmission. The Leuser Ecosystem team are currently using drones in three regions of the ecosystem to monitor encroachment and forest loss. They are also conducting high-resolution mapping of illegal logging and forest destruction based on Global Forest Watch fire reporting.

While the use of drones for anti-poaching has been less productive, mapping of forest destruction in faraway areas using drones has proven highly effective. Mapping and imagery are used to prepare police cases against illegal loggers, and in discussions with local communities and their leaders to reverse destructive practices.

Using drones, we documented critical orangutan habitat being destroyed within Gunung Leuser National Park. The next step will be the major task of removing illegal palm plantations and finally, reforestation. The team also attempted to use FLIR thermal cameras mounted on drones to identify poacher campfire locations.

The current models of affordable drones are not yet reliable in flying over deep forest or at night, risking the loss of expensive equipment. However, as the technology improves, we anticipate that thermal imagery for surveillance will become another key use for drones.



Park Rangers: Code of Conduct

1. Park Rangers will faithfully abide by all laws, rules, regulations, and policies governing the performance of their duties and will commit no act that violates these laws or regulations, or the spirit or intent of such laws and regulations while on or off duty.

2. In personal and official activities, rangers will never knowingly violate any local, state, or federal law or regulation.

3. Rangers will not knowingly commit any act in the conduct of official business or in their personal life that subjects the Park Authority to public censure or adverse criticism.

4. As a park protection officer, rangers will not accept outside employment that will in any way conflict or appear to conflict with law enforcement interests, or jeopardize the activities or mission of the park.

5. As a Park protection officer, rangers will conduct all investigations and law enforcement functions assigned to them impartially and thoroughly, and report the results thereof fully, objectively, and with accuracy.

6. In the investigative process, rangers will be judicious at all times and will not release information pertaining to their official duties, orally or in writing, unless in accordance with the law and established policy.

7. Rangers will accept nothing of value, including favored treatment, from anyone on their own behalf or on behalf of another person. Acceptance of such favors may result in a conflict, or give the appearance of a conflict, with their official duties or effectiveness as a law enforcement officer.

8. Rangers will abide by all rules, regulations, and policies of the Park, including those relating to health, safety, and technical expertise requirements of their position.

9. Rangers will use only the amount of force that is objectively reasonable to accomplish the mission of the Park and Park Authority.

10. Supervisors will not give, and personnel shall not comply with, orders they know to be in violation of criminal laws. Where question or dispute exists over such an order, both supervisor and subordinate will direct the matter to the next level of supervision for resolution.

11. Rangers must understand this Code of Conduct is in addition to requirements imposed on them and applicable to all government employees as cited in the regulations governing responsibilities and conduct of employees.

PARK RANGERS: CODE OF CONDUCT (cont.)

Rangers promise to:

- Maintain themself, their arms, and their equipment in an immaculate state as befits a Park Protection Officer.
- Keep their mind and body clean, alert and strong, for this is their debt to those who depend upon them.
- Be loyal to law and ethical principles above private gain.
- Act impartially to all groups, persons, and organizations.
- Give an honest effort in the performance of their duties.
- Protect and conserve the National Park and relevant areas.
- Disclose fraud, waste, abuse, and corruption to appropriate authorities.
- Fulfill in good faith their obligations as citizens, and pay their debts and local taxes.
- Comply with all laws providing equal opportunity to all persons, regardless of their race, color, religion, sex, national origin, age, or handicap.

Rangers will never:

- Use nonpublic information to benefit themselves or anyone else.
- Solicit or accept gifts from persons or parties that do business with or seek official action from ministry or Park Management (unless permitted by an exception).
- Make unauthorized commitments or promises that bind the government.
- Use government property for unauthorized purposes.
- Take jobs or hold financial interests that conflict with their government responsibilities.
- Take actions that are or give the appearance of being illegal or unethical.

PARK RANGERS: CODE OF CONDUCT (cont.)

Rangers hereby pledge to:

- Abide by an uncompromising code of integrity, taking full responsibility for their actions and keeping their word, adhering to the highest standards of personal conduct and decency.
- Fulfill their legal and ethical responsibilities in their public and personal life.
- Conduct themselves in the highest ethical manner toward seniors, peers and subordinates, and foster respect up and down the chain of command.
- Be honest and truthful in their dealings within and outside the Parks Department.
- Be loyal to duties by ensuring the resources entrusted to them are used in an honest, careful and efficient way.
- Make honest recommendations to their seniors and peers and seek honest recommendations from junior personnel. Encourage new ideas and deliver bad news forthrightly.
- Make decisions and act in the best interest of the Parks Department and the nation, without regard to personal consequences.
- Care for the personal and spiritual well-being of their people.
- Show respect toward all people without regard to race, religion or gender.
- Always strive for positive change and personal improvement.
- Have the courage to meet the demands of their profession.
- Exhibit the highest degree of moral character, professional excellence, quality, and competence in all that they do.

Rangers must review and pledge to this Code of Conduct, and recognize that a violation of this code or provisions of the aforementioned regulations may be cause for disciplinary action or removal from the Department.

Global Conservation - Expected Outcomes: Year 1 - 4

DESCRIPTION	BASELINE CONDITIONS	EXPECTED OUTCOMES FOUR YEARS
Intact Forest and Wildlife Habitat Protected	400,000 hectares under legal protection - 20% park forest under threat	800,000 hectares under actual protection - Less than 5% park forest under threat
Primary Threats	Illegal Land Clearing Illegal Logging Wildlife Poaching Commercial and Local Hunting	No illegal land clearing, industrial logging, commercial hunting. Increase wildlife populations across the board by 10%.
Kilometers Patrolled by Vehicle or Vessel and on Foot	2,000 kms per year 1,000 by vehicle/boat 1,000 by foot patrol	8,000 kms per year 2,000 by vehicle/boat 6,000 by foot patrol
Interdictions	18 Serious Violations 40 Lesser Violations	50+ Serious Violations 120+ Lesser Violations
Citations	45 Citations	200+ Citations
Arrests	22 Arrests	200+ Arrests
Prosecutions	32 Jailed 48 Fines 182 in Process	80+ Jailed 200+ Fines
Long-Term Funding Secured	Government protection funding under $200K per year. No carbon finance. Tourism rev. under $300K year	Government protection funding $500K+ per year. $500K+ per year carbon finance. Tourism revenues $800K+ yearly

Global Conservation - Park and Wildlife Protection					
4-Year Global Park Defense Budget					
Activity	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Total**
STAGE 1 - Global Park Defense					
Threat Assessment	$ 10,000				**$ 10,000**
Park Protection Plan	$ 10,000				**$ 10,000**
SMART Ranger Patrols	$ 40,000	$ 40,000			**$ 80,000**
Transport, Fuel, Ration Support	$ 20,000	$ 20,000			**$ 40,000**
All Ranger Teams Equipped	$ 20,000	$ 10,000			**$ 30,000**
Cellular Trailcam Network	$ 30,000	$ 30,000			**$ 60,000**
Thermal and Long-Range Cameras	$ 12,000	$ 12,000			**$ 24,000**
Community Involvement - Informants	$ 6,000	$ 6,000			**$ 12,000**
Legal and Prosecution Support	$ 12,000	$ 12,000			
Core Threat Area Field Camps	$ 5,000	$ 5,000			**$ 10,000**
Core Area Ranger Communications	$ 10,000	$ 10,000			**$ 20,000**
2 Week GPD I Training	$ 6,000	$ 6,000			**$ 12,000**
Aerial Survey – Forests and Biodiversity	$ 6,000	$ 6,000			**$ 12,000**
Advanced Mapping – Planet	$ 10,000				**$ 10,000**
Master Ranger / OTJ Patrolling	$ 20,000	$ 20,000			**$ 40,000**
STAGE 2 - Global Park Defense					
All Ranger Teams Equipped			$ 8,000	$ 8,000	**$ 16,000**
Legal and Prosecution Support			$ 12,000	$ 12,000	**$ 24,000**
SMART Ranger Patrolling			$ 40,000	$ 40,000	**$ 80,000**
Transport, Fuel, Ration Support			$ 20,000	$ 20,000	**$ 40,000**
Scale-Up Cellular Trailcam Network			$ 40,000	$ 40,000	**$ 80,000**
Thermal and Long-Range Cameras			$ 12,000	$ 12,000	**$ 24,000**
Community Involvement - Informants			$ 4,000	$ 4,000	**$ 8,000**
Core Threat Area Field Camps			$ 6,000		**$ 6,000**
Core Area Ranger Communications			$ 8,000		**$ 8,000**
2 Week GPD II Training			$ 6,000	$ 6,000	**$ 12,000**
Aerial Survey – Forests and Biodiversity			$ 6,000	$ 6,000	**$ 12,000**
Advanced Mapping – Planet				$ 10,000	**$ 10,000**
Master Ranger / OTJ Patrolling			$ 20,000	$ 20,000	**$ 40,000**
Project Assessment and Effectiveness		$ 12,000		$ 12,000	**$ 24,000**
Interdictions – Arrests – Patrol Mileage – Citations –					
Long- Term Sustainability		$ 10,000	$ 10,000	$ 10,000	**$ 30,000**
Carbon for Forest – Corporate Adoption and Carbon Offsets					
Tourism Revenue covers Park Management and Operations					
Government Funding for Protection, Infrastructure					
Secure Matching Co-Funding + Gov't Funding Secured					
TOTAL COSTS	**$217,000**	**$199,000**	**$192,000**	**$200,000**	**$ 808,000**
Moore Foundation Contribution	**$100,000**	**$100,000**	**$100,000**	**$100,000**	**$ 400,000**
Global Conservation Co-Funding	**$117,000**	**$ 99,000**	**$ 92,000**	**$100,000**	**$ 408,000**

ACKNOWLEDGEMENTS

We would like to thank our many valued friends and partners in conservation around the world. Many of who are contributing to the continuing development of our Global Park Defense programs.

Board of Directors:

Jeff Morgan - Executive Director, Global Conservation
Firth Griffith - Founder, Global Sustainability Initiative
Michael Sutton - Executive Director, Goldman Environmental Prize
Michael Finley - President Emeritus, Turner Foundation

Advisory Board:

Dr. Gregory Asner - Director of ASU's Center for Global Discovery and Conservation Science, Arizona State University
Dr. Gerardo Ceballos - Instituto de Ecologia, UNAM Mexico, Visiting Professor, Stanford University
Dr. Eric Dinerstein - Director, Biodiversity & Wildlife Solutions, RESOLVE / Former Vice President for Science, World Wildlife Fund
Suwanna Gauntlett - Chief Executive Officer, Wildlife Alliance Direct Protection for Forests and Wildlife
Martin Goebel - Baja Regional Director, LegacyWorks Group Moebius Partners, LLC
Mike Griffiths - Vice President Ecosystem Services, Floresta Director FKL Leuser Ecosystem Conservation
Angus Parker - Chair, Board of Directors of Island Conservation
Dr. Peter Raven - President Emeritus, Missouri Botanical Garden
Dr. Ian Singleton - Director of Conservation, PanEco Foundation Scientific Director, Sumatran Orangutan Conservation Program

Research, Writing - Dr. Jen Guyton, National Geographic Explorer International League of Conservation Photographers (iLCP) Fellow Digital Storytelling Fellow 2019 | Fulbright Program, U.S. Dept. of State

Global Park Defense Advisor - Greg Brown

Photographers - Paul Hilton, Andrea Pistolesi, Gabriel Urruela
Additional photography contributed by:
Francisco Asturias
Wildlife Alliance

Book Design, Production - W.J. McKay

Section One illustrations by Ava Salzman

Global Conservation - Presidio National Park - PO Box 29278, San Francisco CA 94129
+1(650)814-2045 - globalconservation.org