INTRODUCTION and RESEARCH DESIGN

Wildlife research on aquatic, terrestrial, and arboreal species in the Peruvian Amazon helps us understand better the ecology of species, the impact of climate change, and advances in sustainable use, community-based conservation, one-health, and the emerging green economy. The field research provides the science base for 1) sustainable resource use and community-based conservation, 2) impacts of climate change on biodiversity and people, 3) disease risks, and 4) wildlife trade and recovery of endangered species.

The research studies on all the vertebrate groups and includes the ecology of dolphins, fish, frogs, shorebirds, macaws, primates, ungulates, carnivores, caimans, and lizards. Population trends are recorded for all species, and specific ecological questions vary among the different vertebrate groups.

Research on sustainability provides science for community-based conservation. Studies on sustainable use focus on wildmeat, fish, and palm fruits used by the people for subsistence and market sales. Research is based on population biology, sustainability models, and socio-economic and cultural studies.

Climate change research investigates how wildlife and people have been impacted, especially in the flooded forests where effects have been devastating. Research on climate change studies how intensifications of floods and droughts impact biodiversity and species populations.

Community-based conservation dominates the landscape of Loreto and the project studies the positive community-based conservation trajectory that we currently see and investigates how threats can be minimized and monitored. The Peruvian Amazon of Loreto has gone through a transformation during the first decades of the 21st century. The overuse of the 20th century industrial destructive use of the Amazon has now been replaced by community-based conservation in the form of Community Reserves, Co-managed National Reserves, and Indigenous Territories which currently make up over 65% of the region. Loreto spans over 382,000 km2 of Amazon forests (size of Germany) that is now managed through formal and informal community management plans based on sustainable use and biodiversity conservation.

One-health research is studying the relationships between biodiversity and zoonosis in areas close to the cities and areas in natural forests. A gradient between disease risks and biodiversity was found in each mammalian group, but the human impact and landscape drivers differed. In contrast birds had similar disease risks in all the sites. The result is a multidimensional array of gradients, that shows that all areas of western Amazonia have disease risk to humans.

The Matrix model

The research questions use a Matrix model that includes landscape species (aquatic, terrestrial and arboreal) and Indicator/Resource use species to study the impacts of climate change and resource uses on wildlife species. The matrix model is used to separate out environmental (climate change) and human use (harvesting) impacts on wildlife populations.

Landscape features are divided into aquatic, terrestrial and arboreal. Indicator species are animals that are not directly harvested by people, and changes in their populations are from environmental factors (Fig. 1). Resource use species are animals that are used directly by people (hunting, fishing, collecting) and changes in their populations are from harvesting pressures or environmental factors. Environmental factors can be natural events or human relate, such as climate change, pollution, or degraded forests or rivers.

Figure 1. Species assemblages resulting from the matrix of landscape species and indicator/resource use species.

Landscape - species type	Indicator species	Resource use species
Aquatic	River dolphins Waterfowl Fishing bats Frogs	Fish Caimans River otters - past
Terrestrial	Terrestrial edentates Felids	Ungulates Terrestrial rodents
Arboreal	Small-bodied primates Macaws, parrots & parakeets	Large-bodied primates Game birds Arboreal rodents

We use wildlife surveys to study the population trends of aquatic, terrestrial and arboreal wildlife over time, according to the matrix models. The research design is based on multiyear population analysis of species groups and protocols have been the same for all years from 2009-2026.

We survey terrestrial mammals (ungulates and terrestrial rodents), arboreal mammals (primates and other arboreal mammals) and game birds using transects. The data are analyzed using Distance 6.0 software. Population densities are calculated as number of individuals/km² (ind/km2).

We also survey terrestrial mammals and felids with infrared and motion camera traps, Bushnell HD. Capture rates per species are calculated as independent events as number of individuals/1,000 camera-days (ind/m.c.d.).

We survey macaws, parrots and parakeets using 15-minute point counts set in sampling units separated by 500 m along the shoreline of rivers, lakes and channels. We determine species through visual and auditory identification, and records are taken of number of individuals in a flock and minute of observation. Population trends use number of individuals per point (ind/pt).

We survey fish using green nylon gill nets of 30 meters long, 3 meters deep, and a mesh size of 2.5 inches set for 1 hour in rivers, lakes, channels and flooded forest habitats with weak currents. . Catch per unit effort (CPUE) was calculated as individuals per net-hour (ind/net-hour) and biomass per net-hour (kg/net-hour).

We survey waterfowl by shoreline transects in the morning (5:30-9:00h) and afternoon (16:00-18:30h). All perched or flying waterfowl are recorded. Population abundance of species is calculated as number of individuals/km (ind/km).

We survey dolphins on 5 km diurnal aquatic transects in river, lake and channels, and with one-hour point count observations at dolphin concentrations. Behavioral observations, pod composition and population abundance (ind/km) and density (ind/km2) were calculated.

We survey caimans through visual counts at night (20:00-24:00h), travelling along 5.0 km transects at a velocity of approximately 2 km/hour on a single side of the river, lake or large channel (>40m width) or simultaneously on both sides in smaller channels (<40 m width). Population abundance per species is calculated as number of individuals/km (ind/km).

Amphibians are a good biological indicator and are often thought to be one of the first taxa's to react to environmental degradation and climate change. Abundance can be calculated using CPUE, and density can be estimated using fixed width.