Quo vadis camera trap research?
A 50-year review of camera trap research goals and outcomes

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INTRODUCTION

Recent explosion of camera trapping (CT) studies represents a great experiment and challenge in modern wildlife survey methodology. CT has successfully complemented and sometimes replaced various survey methods. We evaluated different research applications **SCIENCE** and **CONSERVATION** that have used CT in three periods: 1956-1997 (from a previous review), 1998-2008 and 2009-2016 in different parts of the world, and how its advantages and disadvantages have changed over time, in order to provide some insights about the future of CT studies for the conservation of species.

MATERIALS AND METHODS

Three periods: 1956-1997 (Cutler and Swann, 1999) and 1998-2008, 2009-2016 (until July 2016) searched within the Web of Science™ database for 'camera trap' that apply for terrestrial animal.

The objectives of CT studies were classified into two categories **SCIENCE**, with studies on population parameters (distribution, density, presence, occupancy and abundance), methodology, forest ecology, behavior and activity patterns, and **CONSERVATION**, including management, human conflicts and human disturbance, elusive and rare species, habitat fragmentation, logging, hunting, inventory and methodology.

CONCLUSION

- The number of CT studies has increased abruptly from **2,63 papers/year** in the first period, to **120 papers/year** in the last period. Most CT studies have a scientific perspective focused on population parameters, behavior and activity patterns and methodology, but conservation applications with leading topics like management, conflicts with human and human disturbance or habitat fragmentation, are increasing from less than **1% to 16%** in these time periods.
- The geographic and animal taxa focus has shifted from a first period dedicated mostly to birds in North America, to mammals (subjects in 90% CT studies) and the tropics **South Amrecia and Asia**, with special attention paid to big carnivores
- More than half of CT studies **dedicated to conservation** during last two decades took place in tropical countries in Asia, Africa and South and Central America.
- Studies with **multiple objectives and multiple taxa** become more common in the last decades, as complexity of research has increased in order to address current conservation problems.

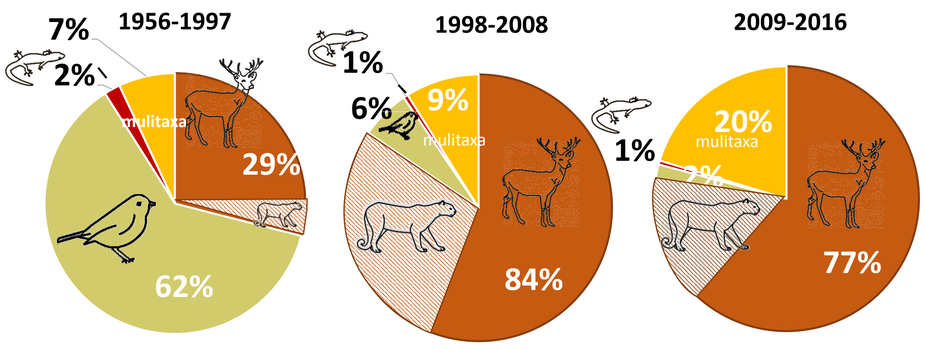

Figure 1. Variety of animal taxa present in CT studies during three periods: 1956-1997 (adapted from Cutler and Swann, 1999), 1998-2008 and 2009-2016.

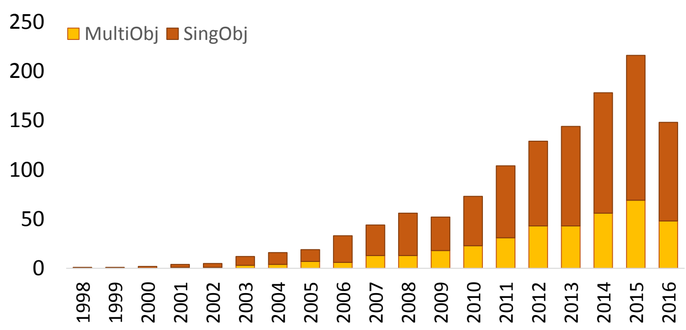

Figure 2. Number of CT single- and multiple objective studies in 1998-2016 (until July 2016).

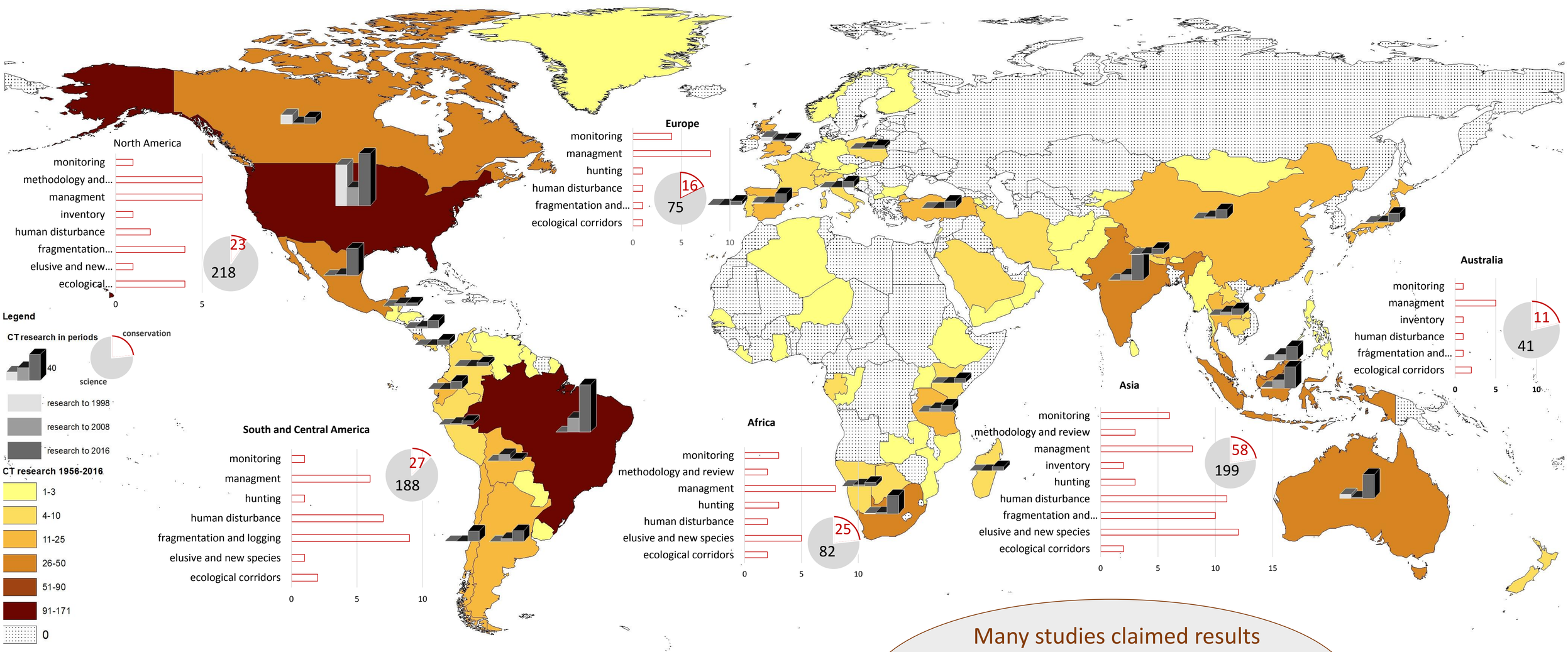

Figure 3. Number of CT studies in world distribtuion from three periods. For some countries change in number of studies is presented in column grafic. For each continent numer of science nd conservation studies from all three periods it showed, and number of different studies dedicated to conservation is presented in seperated column grafics.

Many studies claimed results of "conservation application", but do not give details on the expected application, nor do they provide quantitative data for this claim.

RESULTS

Sample of 107 (Cutler and Swan, 1999), 156 (1998-2008) and 840 (2009-2016) studies were taken in account. Change in animals taxa sampled with camera traps has changed (Fig.1). Number of CT research rises constantly (Fig.2) among continents (Fig.3).

Adventage of CT

- They are less invasive, faster in use, cheaper than long- term survey.
- There is a possibility of registration of nocturnal and / or cryptic animals
- Independent of weather or inaccessible sites
- Identification bias is reduced as different people can revised photos/videos.

Disadventage of CT

- Mechanical problems were present in first revised period, while currently are not significant obstacle.
- Change in the behavior of the animals (human presence, smell, bait, local changes in vegetation) can bias observation success.
- CT is expensive equipment, easy to be stolen.
- Using a lot of CT require complicated logistics.

LOOKING INTO THE FUTURE

- Technological advance allows increasing complexity of studies, both in equipment and analysis methods, what results in an opportunity to address conservation and management problems.
- More important than the technical details, are the methodological specifications that should be explicitly related to **the objectives of the study and experimental design** that would increase the potential for comparison and synthesis of results between studies.
- The estimation of abundance and monitoring are not considered as independent activities, but as part of a larger sequential decision-making processes process, leading to the development of new data management schemes at the global level such as **Tropical Ecology Assessment and Monitoring** network TEAM (Ahumada et al. , 2013), the **Wildlife Image Index and Tigers Forever** .
- Probable combination of trap camera and **unmanned aerial vehicle (UAV)** methodology.

LITERTURA: Ahumada et al. 2013. Monitoring the status and trends of tropical forest terrestrial vertebrate communities from camera trap data: a tool for conservation. *PloS one*, *8*(9), e73707. ; Cutler and Swann. 1999. Using remote photography in wildlife ecology: a review. Wildlife Society Bulletin:571-581., O'Connell et al .2010. Camera traps in animal ecology: methods and analyses. Springer Science & Business Media.

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