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LUCIANA COSTA DE CASTILHO

AVALIAÇÃO DOS COMPORTAMENTOS E ATITUDES DE MORADORES RURAIS RELACIONADAS À CONSERVAÇÃO EM ÁREAS PROTEGIDAS NO SUL DA BAHIA, BRASIL

ILHÉUS – BAHIA
2016

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Tese apresentada ao Programa de Pós-Graduação em Ecologia e Conservação da Biodiversidade da Universidade Estadual de Santa Cruz como parte dos requisitos para obtenção do grau de Doutor em Ecologia e Conservação da Biodiversidade.

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AVALIAÇÃO DOS COMPORTAMENTOS E ATITUDES DE MORADORES RURAIS RELACIONADAS À CONSERVAÇÃO EM ÁREAS PROTEGIDAS NO SUL DA BAHIA, BRASIL

RESUMO

A principal estratégia global para conservação da biodiversidade tem sido a criação de áreas protegidas, porém conflitos no manejo das áreas com as populações locais muitas vezes tem minado o sucesso das ações de conservação como também tem prejudicado o meio de vida dessas populações humanas. O objetivo deste estudo foi investigar comportamentos, especialmente relacionados ao uso da fauna, e atitudes de conservação de moradores rurais com relação às áreas protegidas e suas políticas de conservação. Esse estudo buscou fornecer informações para o Plano de Ação Nacional para Conservação dos Mamíferos da Mata Atlântica Central do Instituto Chico Mendes, através da inclusão das espécies-alvo do Plano no grupo focal de espécies a serem investigadas. Através de 169 entrevistas diretas e de 182 entrevistas utilizando a técnica de questionamento indireto, "Randomized Response Technique", foram investigados aspectos relacionados com a prática da caça, a existência de conflitos entre pessoas e animais silvestres, as atitudes e a percepção dos moradores com relação à conservação da fauna e das áreas protegidas, e a realização de outros comportamentos necessários para o meio de vida dos moradores. O estudo foi desenvolvido na Reserva Biológica de Una, no Refúgio de Vida Silvestre de Una, no Parque Nacional Serra das Lontras, e na zona de amortecimento conectando essas áreas. Com relação à caça, foi observado que essa prática ocorre em toda área de estudo, principalmente para complementar a alimentação dos moradores, seja para subsistência ou para a apreciação da carne de animal silvestre. A caça foi significativamente relacionada com o baixo nível de escolaridade. As estimativas de consumo foram maiores para espécies comuns e preferidas, como *Cuniculus paca*, *Dasypus novemcinctus* e *Pecari tajacu*. Já para as espécies ameaçadas, tais como *Bradypus torquatus*, *Leontopithecus chrysomelas*, *Sapajus xanthosternos* e *Chaetomys subspinosus*, a proporção de consumo foi baixa, porém ainda é motivo de preocupação considerando que baixas taxas de abate podem causar grandes efeitos sobre pequenas

populações de espécies protegidas. Com relação às atitudes e comportamentos, atitudes negativas refletiram a insatisfação dos entrevistados com a proibição e restrição do uso de recursos naturais e também destacaram o desejo das pessoas em realizar comportamentos desfavoráveis à conservação, como a caça e a substituição de matas e capoeiras por agricultura de pequena escala. Foi verificada também uma elevada prevalência de comportamentos desfavoráveis, sugerindo que o cumprimento das políticas atuais de conservação pelos moradores locais é fraca. Os resultados sugerem que atitudes favoráveis dos entrevistados e níveis mais elevados de educação formal podem ser bons preditores de comportamentos positivos. Melhorar o apoio local e aumentar o cumprimento das políticas de conservação em áreas protegidas é necessário para garantir a eficácia dessas áreas a longo prazo e para garantir a conservação das espécies, especialmente as endêmicas e ameaçadas de extinção. Para isso, além de aumentar os esforços de fiscalização, é necessário envolver os moradores locais, garantindo que as pessoas e suas preocupações sejam incluídas nas estratégias de manejo dessas áreas. Estratégias que busquem o desenvolvimento de programas de educação e comunicação com os moradores locais, programas de assistência agrícola e projetos de segurança alimentar são altamente recomendadas.

Palavras-chave: Caça. Comunidades locais. Entrevistas. Mamíferos ameaçados. Mata Atlântica. Randomized Response Technique. Uso de recursos naturais.

ASSESSMENT OF BEHAVIORS AND ATTITUDES OF RURAL RESIDENTS TOWARDS CONSERVATION IN PROTECTED AREAS OF SOUTHERN BAHIA, BRAZIL

ABSTRACT

Protected areas have become a key conservation strategy to protect global biodiversity; however, conflicts between management of these areas and local people have often undermined conservation goals as well as people's livelihoods. This study investigated behaviors, especially related to use of wildlife, and attitudes of rural residents towards protected areas and its conservation policies. We aimed to provide information for the National Action Plan for the Conservation of Atlantic Forest Mammals coordinated by the Chico Mendes Institute for Biodiversity Conservation, by including target species of the Plan in the group of focal species to be investigated. Aspects related to hunting, conflicts between people and wild animals, attitudes and perceptions of residents towards wildlife conservation and protected areas, and other behaviors necessary to people's livelihood were investigated using 169 direct interviews and 182 interviews using an indirect questioning technique, the Randomized Response Technique. The study was developed in Una Biological Reserve, Una Wildlife Refuge, Serra das Lontras National Park and in the buffer zone connecting these areas. With respect to hunting, we found that this practice is widespread in the study area, and is performed mainly to complement the residents' diet, either for subsistence or for appreciation of wild meat. Hunting was significantly associated with low level of education. Consumption estimates were higher for common and preferred species such as *Cuniculus paca*, *Dasypus novemcinctus* and *Pecari tajacu*. Although the level of consumption of threatened species, such as *Bradypus torquatus*, *Leontopithecus chrysomelas*, *Sapajus xanthosternos* e *Chaetomys subspinosus*, was low, it is still a motive of concern as even a low rate of hunting can have large effects on small populations of endangered species. Regarding attitudes and behaviors, negative attitudes reflected dissatisfaction with prohibition and restrictions on use of natural resources and also highlighted people's desire to perform unfavorable behaviors towards wildlife and environment conservation, such as hunting and

forest replacement for small-scale agriculture. We also found a high prevalence of unfavorable behaviors suggesting that local residents' compliance with current conservation policies is weak. Our results suggested that respondents' favorable attitudes and higher levels of formal education may be good predictors for positive behaviors. Improving local support and increasing compliance with conservation policies in protected areas is necessary to ensure long-term efficacy of these areas and to ensure species conservation, especially for endemic and threatened species. Therefore, in addition to improve law enforcement efforts, it is necessary to involve local people, ensuring that residents and their concerns will be contemplated when developing management strategies for these areas. Strategies seeking to develop education and communication programs with local residents, agricultural assistance programs and food security projects are highly recommended.

Keywords: Atlantic Forest. Hunting. Interviews. Local people. Randomized Response Technique. Threatened mammals. Use of resources.

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INTRODUÇÃO

A criação de áreas protegidas (APs) é uma das principais estratégias para conservação da biodiversidade. Porém, atividades antrópicas, como a caça e desmatamento, continuam ameaçando a integridade das APs (CAREY et al., 2000; LAURENCE et al., 2012). Além disso, conflitos entre comunidades locais e APs, particularmente relacionados a restrições sobre o uso de recursos naturais (HEINEN, 1993; KIDEGHESHO et al., 2007; NEPAL; WEBER, 1995) muitas vezes têm minado o sucesso das ações de conservação. Com o objetivo de superar esses problemas, nas últimas décadas as políticas globais de APs têm buscado melhorar o manejo das áreas através do envolvimento dos moradores locais na criação e estabelecimento das APs e melhorar a partilha de benefícios gerados pela conservação da biodiversidade (MCNEELY, 1994; NAUGHTON et al., 2005). Consequentemente, entender a relação entre moradores locais e APs, investigando as atitudes, percepções e as práticas dessas pessoas com relação a conservação, tem cada vez mais recebido atenção de conservacionistas.

A caça tem sido uma das práticas de maior preocupação nas últimas décadas, pois a exploração insustentável da carne de animais silvestres tem ameaçado a sobrevivência das espécies e também ameaçado a segurança alimentar das pessoas que dependem da carne de animais silvestres para se alimentar (FOERSTER et al., 2011; MILNER-GULLAND; BENNETT, 2003). Além de causar impacto direto sobre as espécies, a caça insustentável tem impactado a funcionalidade ecológica dos ecossistemas, principalmente através da remoção de agentes dispersores e predadores de sementes (CULLEN JR et al., 2001; WRIGHT et al., 2007). Em diversos países, estudos têm investigado o consumo da carne de caça (e.g. GOLDEN, 2009; GOLDEN et al., 2014; MARTIN et al., 2012), estimado a abundância e densidade de espécies em locais com baixa e alta intensidade de caça (e.g. BITETTI et al., 2008; NARANJO; BODMER, 2007; TOPP -JØRGENSEN et al., 2009), investigado os métodos e ferramentas utilizadas nas atividades de caça (e.g. FERNANDES-FERREIRA et al., 2012; PEREIRA; SCHIAVETTI, 2010) e avaliado a sustentabilidade da caça no intuito de auxiliar no manejo da atividade e na conservação das espécies mais impactadas (e.g. LEVI et al., 2011; PERES; NASCIMENTO, 2006). Além disso, autores têm investigado os conflitos existentes na interação entre pessoas e animais silvestres (GILLINGHAM; LEE, 2003; HILL,

1998; HOCKINGS; HUMLE, 2009; WANG; MACDONALD, 2006), considerando que esses conflitos podem prejudicar tanto a sobrevivência dos animais como diminuir o apoio dessas pessoas nos esforços conservacionistas (GADD, 2005).

Além da caça, autores têm investigado o uso de recursos naturais, as percepções e as atitudes de moradores residentes em APs com relação à conservação (BARAL; HEINEN, 2007; DE BOER; BAQUETE, 1998; HOLMES, 2003). Entender como os moradores locais percebem e opinam sobre as APs e sobre suas políticas de conservação tem sido considerado fundamental para auxiliar no planejamento de políticas ambientais eficientes (INFIELD, 1988), para fortalecer o apoio destas pessoas à conservação dos recursos naturais (FIALO; JACOBSON, 1995) e consequentemente garantir a conservação dessas áreas à longo prazo (ALLENDORF, 2007). As proibições e restrições no uso de recursos geralmente resultam em atitudes negativas dos moradores e problemas para a gestão de APs (FIALO; JACOBSON, 1995; KIDEGHESHO et al., 2007). Outros aspectos como o desenvolvimento socioeconômico de comunidades locais (BARAL; HEINEN, 2007), os conflitos existentes entre pessoas e vida selvagem (GADD, 2005; HILL, 1998) e os benefícios e as ameaças que as áreas protegidas representam para estas pessoas (ALLENDORF et al., 2006) também têm sido associados às atitudes de conservação de moradores locais em APs.

Melhorar o entendimento dessa relação entre pessoas e APs, bem como todas as atividades que possam causar conflitos de interesse e ameaças a biodiversidade, é fundamental para viabilizar estratégias de manejo mais eficientes para essas áreas e para conservação das espécies (ALEXANDER, 2000; FIALLO; JACOBSON, 1995). Porém, obter informações sobre o uso de recursos naturais, quando este é ilegal, é uma tarefa difícil, particularmente quando os moradores estão conscientes sobre a ilegalidade dessas atividades. Diversos métodos têm sido utilizados para investigar informações sobre o uso de recursos naturais como entrevistas diretas, registros de fiscalização, observações indiretas e diretas da fauna, questionamento indireto como a “Randomized Response Technique”, entre outros. Porém cada um dos métodos tem suas vantagens e desvantagens, o que torna a combinação das técnicas um avanço importante para obtenção de dados confiáveis para serem utilizados nos projetos de conservação (BITANYI et al., 2012; GAVIN et al., 2010).

No Brasil, conflitos entre comunidades locais e APs são constantes, considerando que grande parte das áreas são ocupadas por moradores e restrições ao uso de recursos naturais limitam o desenvolvimento de atividades que garantem o meio de vida dessas populações humanas (ABACHERLI, 2001; ARRUDA, 1999; FERREIRA, 2004; FERREIRA; FREIRE 2009). Conflitos entre pessoas e animais silvestres também se tornaram uma preocupação nos

últimos anos (MARCHINI et al., 2015), pois estudos mostram que a interação entre pessoas e fauna tem ameaçado a sobrevivência das espécies tanto dentro como fora de APs (CONFORTI; AZEVEDO, 2003; ZIMMERMANN et al., 2005). A caça, apesar de proibida em todo país (Lei Federal Federal 9605/98), exceto quando necessária para saciar a fome de um indivíduo, é amplamente praticada e tem sido considerada uma das principais ameaças a fauna em APs na Mata Atlântica (CANALE et al., 2012; CHIARELLO, 2000; SCHIAVETTI et al., 2013), Amazônia (CARVALHO; PEZZUTI, 2010) e outras regiões do nordeste do país (FERNANDES-FERREIRA et al., 2012; FERNANDES-FERREIRA et al., 2013).

O presente estudo investigou comportamentos, principalmente relacionados ao uso da fauna, e atitudes de moradores rurais relacionadas a APs e suas políticas de conservação em três APs de Proteção Integral (Reserva Biológica de Una, Refúgio de Vida Silvestre de Una e Parque Nacional Serra das Lontras) e em uma zona de amortecimento na Mata Atlântica, localizadas na região sul do Estado da Bahia. A Mata Atlântica brasileira é considerada um dos hotspots para conservação da biodiversidade do mundo (MYERS et al., 2000; TABARELLI et al., 2005). Porém, apesar de restar menos de 12% de sua formação original (RIBEIRO et al., 2009), práticas exploratórias como desmatamento, caça, corte ilegal de madeira, coleta ilegal de plantas e o uso intensivo da terra para agricultura, silvicultura e pastagens, continuam a destruir as áreas remanescentes (GALINDO-LEAL; CÂMARA, 2003; TABARELLI et al., 2005). Aproximadamente 9% da área de floresta remanescente da Mata Atlântica está protegida em APs (RIBEIRO et al., 2009), porém a maioria destas áreas não possui tamanho suficiente para manter populações viáveis e necessitam de uma administração mais eficiente (BRIGHT; MATTOON, 2001; LEAL-GALINDO; CÂMARA, 2003), pois carecem de recursos humanos e financeiros para sua regulamentação, monitoramento e fiscalização (SCHIAVETTI et al., 2013).

As três APs investigadas nesse estudo estão localizadas na parcela mais representativa de Mata Atlântica do Nordeste brasileiro, apresentando grande riqueza de espécies, incluindo espécies endêmicas (ALGER; CALDAS, 1994; GALINDO-LEAL; CÂMARA, 2005; MARTINI *et al.*, 2007; RIBEIRO *et al.*, 2009). A Reserva Biológica de Una (REBIO Una) é a AP mais antiga, tendo sido estabelecida originalmente em 1980. Em 2007, foi criado o Refúgio de Vida Silvestre de Una (RVS Una), área que anteriormente funcionava como a área de amortecimento da REBIO Una. Já o Parque Nacional Serra das Lontras (PARNA Lontras) e sua Zona de Amortecimento (ZA) foram criados em 2010. Nas áreas estabelecidas há mais tempo (REBIO e RVS de Una), ações de fiscalização e manejo, como programas de educação ambiental e suporte técnico para agricultores, tem sido implementadas de forma conjunta

(IBAMA, 1997; SANTOS; BLANES, 1997;1999). Enquanto que no PARNA Lontras e ZA, criados mais recentemente, as ações de manejo ainda são escassas, incluindo esforços de fiscalização.

O objetivo deste estudo foi (1) investigar informações sobre a caça, identificando como os moradores estão utilizando a fauna e quais são as espécies mais consumidas, focando especialmente em espécies de mamíferos ameaçados; (2) identificar qual a prevalência de comportamentos relacionados à conservação da fauna e do ambiente, (3) investigar as atitudes dos moradores com relação às APs e suas políticas de conservação da fauna e do ambiente, e (4) identificar fatores que possam estar influenciando os comportamentos e as atitudes, como por exemplo: fatores sociais (variáveis socioeconômicas), localização (AP ou zona de amortecimento), conflitos com a fauna, percepções relacionados à AP e atividades ilegais e percepção sobre fiscalização. Com base nas informações abordadas acima e considerando que as três APs e a zona de amortecimento possuem diferentes ações de manejo e tempo de estabelecimento, nós testamos as seguintes hipóteses: (1) a prevalência de comportamentos desfavoráveis, incluindo a caça, será maior na AP estabelecida há menos tempo e na zona de amortecimento, (2) atitudes desfavoráveis relacionadas à conservação serão mais frequentes entre moradores da AP estabelecida há menos tempo e da zona de amortecimento; (3) fatores como variáveis socioeconômicas, intensidade dos conflitos com a fauna e percepções negativas sobre às APs serão fatores a influenciar os comportamentos e atitudes de conservação.

O objetivo final desse estudo foi fornecer informações para o Plano de Ação Nacional para Conservação dos Mamíferos da Mata Atlântica Central do Instituto Chico Mendes, que tem como meta reduzir a pressão de caça sobre os mamíferos ameaçados na região sul da Bahia. Além disso, o trabalho buscou fornecer informações que possam auxiliar no manejo das APs, principalmente na redução de conflitos com os moradores locais.

A tese está organizada em três capítulos que foram estruturados em forma de manuscritos para publicação. Especificamente, no capítulo 1 nós fizemos uma revisão sobre trabalhos de caça em Áreas Protegidas; no capítulo 2 nós investigamos a caça nas APs do sul da Bahia, dando um enfoque para espécies de mamíferos endêmicos e ameaçados da região; e no capítulo 3 nós identificamos as atitudes e comportamentos dos moradores rurais relacionados à conservação nas APs da região sul da Bahia. O segundo e o terceiro capítulo foram redigidos em inglês, pois os respectivos manuscritos estão sendo desenvolvidos em parceria com a Dra. E.J. Milner-Gulland (supervisora do Doutorado Sanduíche na Inglaterra):

Capítulo 1- Uma revisão sobre estudos de caça em Áreas Protegidas.

Capítulo 2- Illegal hunting of threatened mammal species in Protected Areas of the Atlantic Forest.

Capítulo 3- Behaviours and attitudes of rural residents towards wildlife and environmental policies in Protected Areas of the Northeastern Atlantic Forest.

CAPÍTULO 1

UMA REVISÃO SOBRE ESTUDOS DE CAÇA EM ÁREAS PROTEGIDAS

(Manuscrito formatado nas normas da revista Biota Neotropica)

Uma revisão sobre estudos de caça em Áreas Protegidas

Resumo: Apesar dos esforços para conservar a fauna em áreas protegidas, ameaças como a caça colocam em risco a sobrevivência de muitas espécies. Há uma preocupação crescente para investigar como as pessoas estão usando animais silvestres dentro e no entorno de áreas protegidas. Com o objetivo de avaliar o que tem sido investigado e como tem sido feitos os trabalhos, nós realizamos uma revisão de artigos que investigaram a caça em áreas protegidas. Nós selecionamos 112 trabalhos entre 1992 e 2015 nas bases de dados ISI Web of Knowledge e Scopus. A maior parte das publicações avaliou o efeito da caça sobre a fauna ou descreveram os padrões da caça em comunidades rurais e indígenas. Foram identificados 11 métodos para coletar dados, sendo o questionamento direto o método mais utilizado para investigar a caça. Estudos recentes têm sugerido que a combinação de diferentes técnicas para coletar dados pode permitir uma melhora significativa na validade das informações. Além disso, sugestões dos autores dos trabalhos selecionados destacam pontos de extrema importância para a discussão de medidas de manejo e controle da caça. Embora o número de trabalhos sobre a caça em áreas protegidas tenha aumentado nos últimos anos, considerando a importância de melhor compreender as motivações da prática de caça e as suas consequências sobre a fauna e ecossistemas, destacamos a necessidade de realizar mais pesquisas sobre o assunto mundialmente.

Palavras-chave: Comunidades locais, defaunação, manejo da fauna, carne de animal silvestre, uso ilegal de recursos.

Abstract: Despite actions to protect wildlife in protected areas, threats such as hunting endanger the survival of many species. There is a growing concern to investigate how people are using wildlife inside and around protected areas. In order to assess what has been

investigated and how research has been done, we conducted a review of papers on hunting in protected areas. We selected 112 papers between 1992 and 2015 in ISI Web of Knowledge and Scopus databases. Most publications evaluated the effect of hunting on wildlife or described the hunting patterns in rural and indigenous communities. We identified 11 methods to collect data, with direct questioning being the most widely used method to investigate hunting. Recent studies have suggested that a combination of different techniques to collect data may allow a significant improvement on data validation. Moreover, suggestions from authors highlight important aspects for discussion of hunting management in protected areas. Although the number of studies on hunting in protected areas have increased in recent years, considering the importance to better understand drivers of hunting and its consequences on wildlife and ecosystems, we highlight the need for more research on the subject worldwide.

Keywords: Defaunation, illegal use of resources, local people, wild meat, wildlife management.

Introdução

A criação de áreas protegidas (APs) é uma ferramenta importante para conservação da fauna e seus habitats (IUCN 2014). No entanto, apesar dos esforços para proteger a vida selvagem dentro (e fora) de APs, ameaças como a caça põe em perigo a sobrevivência de muitas espécies (Carey et al. 2000, Bruner et al. 2001). Nas últimas décadas, a caça insustentável tem sido considerada a principal ameaça para a vida silvestre em regiões tropicais (Robinson & Redford 1991, Bennett et al. 2002, Milner-Gulland & Bennett 2003). Mundialmente, a exploração da carne de caça tem aumentado por causa do aumento das populações humanas, do avanço das tecnologias de caça e do maior acesso às florestas, através de estradas e melhoria das redes rodoviárias (Bennet & Robinson 2000, Bennet et al.

2002). Consequentemente, a caça tem causado a extinção local ou mesmo global de espécies (Bennet & Robinson 2000, Milner-Gulland & Bennett 2003), afetado a funcionalidade ecológica dos ecossistemas (Cullen Jr et al. 2001, Wright et al. 2007), além de prejudicar comunidades locais que dependem do consumo de carne de animais silvestres para sobreviver (Milner-Gulland & Bennett 2003).

Considerando o potencial impacto da caça sob as espécies e ecossistemas, há um crescente interesse em investigar como as pessoas estão usando animais silvestres, especialmente dentro e no entorno de APs, e quais são os impactos desse uso sobre as espécies. Em muitos países, estudos têm investigado o consumo da carne de caça (e.g. Golden 2009, Martin et al. 2012, Golden et al. 2014), estimado a abundância e densidade de espécies em locais com baixa e alta intensidade de caça (e.g. Naranjo & Bodmer 2007, Di Bitetti et al. 2008,Topp-Jørgensen et al. 2009), entrevistado os moradores locais para avaliar a frequência, métodos e ferramentas utilizadas nas atividades de caça (e.g. Pereira & Schiavetti 2010, Fernandes-Ferreira et al. 2012) e a motivação para estarem caçando (e.g. Goldman et al. 2013, Carvalho et al. 2014). Além disso, pesquisadores têm avaliado a sustentabilidade da caça no intuito de auxiliar no manejo da atividade e na conservação das espécies mais impactadas (e.g. Peres & Nascimento 2006, Levi et al. 2011).

No entanto, obter informações confiáveis sobre as práticas de caça, quando esta é proibida por lei, é uma tarefa difícil, particularmente quando os moradores estão conscientes sobre a ilegalidade dessa atividade. Métodos como entrevistas diretas, registros de patrulha, observações diretas e indiretas, Técnica de Resposta Randomizada (“Randomized Response Technique”), dentre outros, têm sido utilizados para investigar o uso ilegal de recursos naturais, incluindo a caça ilegal (Gavin et al. 2010). Segundo esses autores, a escolha adequada e combinação de diferentes técnicas pode ser um passo importante para obter dados confiáveis para serem usados em programas de conservação.

Nesse estudo, nós realizamos uma revisão de trabalhos que investigaram a caça em APs e/ou os efeitos dessa atividade sobre a fauna e ecossistemas em geral. Nós consideramos trabalhos desenvolvidos em APs de proteção integral, APs de uso sustentável e Reservas Indígenas, bem como trabalhos relacionados tanto com a caça legal como ilegal. O objetivo deste trabalho foi obter uma visão geral da produção científica sobre caça em APs, fornecendo informações que melhorem o entendimento de como os trabalhos têm sido desenvolvidos, quais aspectos têm sido investigados, além de destacar sugestões e conclusões dos autores sobre a questão da caça e possíveis melhorias para o manejo ou controle dessa atividade em APs.

Material e métodos

Para selecionar os artigos sobre caça em APs, nós fizemos uma busca por artigos publicados nas bases de dados ISI Web of Knowledge e Scopus utilizando as palavras-chave: hunting e protected areas. A busca dessas palavras-chave foi feita no título dos artigos, resumo e palavras-chave. Todos os artigos publicados entre 1992 até dezembro de 2015 foram selecionados. Após a seleção inicial, nós realizamos uma triagem, a partir da leitura dos resumos, para garantir que os trabalhos selecionados estavam relacionados com o assunto pretendido. Consideramos somente os trabalhos que tivessem em seus objetivos a investigação da caça ou a avaliação dos efeitos da caça sobre a fauna ou flora. Trabalhos realizados no entorno de APs (e.g. zonas de amortecimento) também foram considerados. Porém, trabalhos de revisão sobre o assunto não foram considerados na seleção.

Analisamos cada artigo para obter as seguintes informações: ano de publicação, país onde o trabalho foi desenvolvido, tipo de caça (legal ou ilegal), grupo da fauna investigada, objetivo do trabalho, métodos utilizados para coletar dados, vantagens e desvantagens dos métodos de coleta, métodos utilizados para analisar os dados, e conclusões e/ou sugestões

para melhoria do manejo e controle da caça em APs. As informações investigadas nos artigos selecionados foram registradas em planilhas do Microsoft Excel, permitindo uma melhor organização e descrição dos dados. Para facilitar a análise dos objetivos dos trabalhos, nós criamos sete categorias para agrupar os artigos com objetivos semelhantes, tais como: avaliar o efeito da caça sobre a fauna, descrever os padrões de caça, avaliar o efeito do manejo sobre a caça, avaliar o efeito da caça sobre a composição da flora, avaliar o efeito da caça sobre as pessoas, avaliar a sustentabilidade da caça e testar métodos para investigar a caça. Para análise das sugestões dos autores sobre manejo da caça, nós destacamos os pontos que consideramos pertinentes para discussão do assunto, agrupando questões semelhantes citadas pelos autores, como por exemplo: o manejo da densidade populacional humana que habita as APs, a questão do manejo da caça esportiva ("trophy hunting"), o controle da caça em comunidades locais residentes de APs e seu entorno e os efeitos da caça insustentável sobre a composição das florestas e fornecimento de recursos alimentares. Considerando que nossa busca por artigos foi realizada apenas com uma combinação de palavras-chaves (Hunting e protected areas) e utilizou apenas duas bases de dados, não incluindo trabalhos publicados em revistas não indexadas, nós reconhecemos que nossa seleção de artigos é limitada e que isso provavelmente possa estar subestimando o número real de trabalhos produzidos em cada país.

Resultados e Discussão

Foram identificados 112 artigos (Material Suplementar) que investigaram a temática da caça em APs no período de 1992 a dezembro de 2015. Os trabalhos selecionados foram realizados em 38 países, sendo a Tanzânia, Peru, Brasil, Madagascar e Camarões os países com maior número de publicações sobre o assunto (Tabela 1).

Tabela 1. Principais países onde se desenvolveram os trabalhos sobre caça em áreas protegidas (APs). Somente países com 3 ou mais trabalhos publicados foram considerados.

País	Nº de artigos publicados	Nº total de APs terrestres[1]
Tanzânia	24	607
Peru	9	168
Brasil	8	1864
Camarões	7	103
Madagascar	7	97
Zimbabwe	6	243
Gabon	4	21
Argentina	3	304
Cote d'Ivoire	3	241
Gana	3	316
México	3	880
Uganda	3	712
Nigéria	3	994

[1] Fonte: www.protectedplanet.net (Acesso em 2014).

Ao avaliar o número de publicações por ano, é possível observar um aumento de artigos sobre caça em APs, principalmente nos últimos cinco anos (Figura 1).

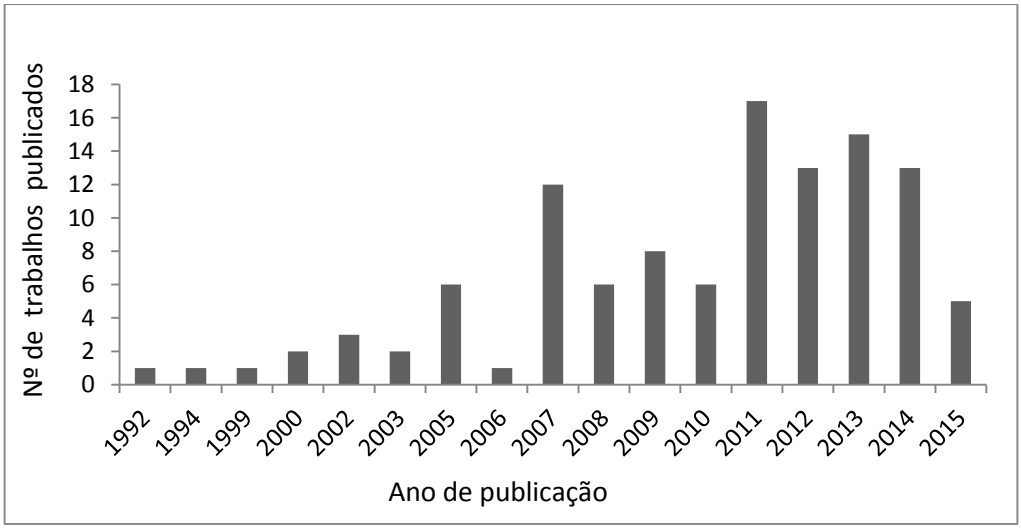

Figura 1. Número de publicações investigando a caça em áreas protegidas.

Dentre os trabalhos selecionados, 45% investigaram a caça ilegal, 31% avaliaram tanto a caça ilegal como legal e 24% investigaram a caça legal. Com relação ao grupo-alvo de animais silvestres estudado, a maior parte dos trabalhos investigou a caça de vertebrados terrestres de forma geral, seguido do grupo de mamíferos (Figura 2). Os mamíferos geralmente estão entre as espécies mais investigadas, pois além de ser uns dos grupos mais focados por trabalhos em conservação, são os alvos preferidos por caçadores (Redford et al. 2011).

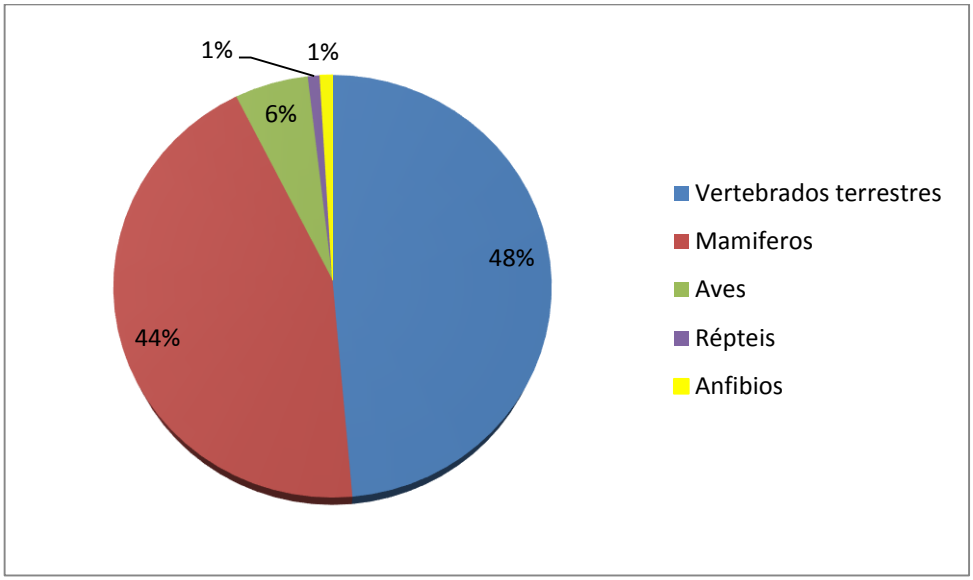

Figura 2. Proporção de artigos sobre caça em áreas protegidas investigando diferentes grupos de animais silvestres.

1. Quais são os objetivos dos trabalhos que investigam a caça em APs?

Os objetivos dos trabalhos sobre caça em APs foram divididos em sete categorias (Tabela 2).

Tabela 2. Objetivos dos trabalhos sobre caça em áreas protegidas.

Categoria	**Nº de trabalhos**
Avaliar o efeito da caça sobre a fauna	47
Descrever o padrão de caça	42
Avaliar o efeito do manejo sobre a caça	11
Avaliar o efeito da caça sobre a composição da flora	3
Avaliar o efeito da caça sobre pessoas	3
Avaliar a sustentabilidade da caça	3
Testar métodos para investigar a caça	3

Na maioria dos trabalhos que buscaram avaliar o efeito da caça sobre a fauna, os autores compararam a abundância ou densidade de uma ou mais espécies entre áreas caçadas e áreas não-caçadas, especialmente APs de uso restrito (e.g. Averbeck et al. 2009, Endo et al. 2010, Crosmary et al. 2015). Para descrever a caça, alguns trabalhos investigaram as práticas atuais de caça utilizadas por populações rurais ou indígenas (e.g. Colell & Mate 1994, Altrichter 2005, Espinosa et al. 2014), identificaram quem são os caçadores, as motivações e as espécies caçadas (e.g. Gardner et al. 2014) e avaliaram o consumo de animais silvestres (e.g. Mgawe et al. 2012). Para avaliar o efeito do manejo sobre a caça, estratégias de manejo e proteção foram avaliadas quanto a sua eficiência para proteger a AP de caçadores (e.g. Kiringe et al. 2007, Nielsen & Meilby 2013). Trabalhos que avaliaram os efeitos da caça sobre a composição da flora compararam o recrutamento de plântulas de espécies arbóreas dispersadas por mamíferos (alvo de caça) entre áreas com caça e áreas sem caça (e.g. Nunez-Iturri & Howe 2007, Nunez-Iturri et al. 2008). O efeito da caça sobre pessoas foi avaliado, por exemplo, através da investigação do risco de anemia em crianças que consumiam ou não a carne de animais silvestres em comunidades remotas (Golden et al. 2011) e através da análise dos impactos sociais da caça esportiva ("trophy hunting") sobre as comunidades locais (Yasuda 2011). Para avaliar a sustentabilidade da caça, os autores desenvolveram modelos utilizando dados como taxas de abates ou consumo e estimativas de produção das espécies (e.g. Golden 2009), além de dados de localização de assentamentos e densidade populacional

humana (e.g. Levi et al. 2011). Por fim, buscando testar métodos mais adequados para investigar informações sobre caça ilegal, autores testaram o uso de técnicas inovadoras como "Randomized Response Technique" (e.g. Solomon et al. 2007, Razafimanahaka et al. 2012) e testaram a combinação de diferentes técnicas para avaliar sua efetividade em obter dados (e.g. Knapp et al. 2010).

2. Quais métodos têm sido utilizados para coletar dados sobre caça em APs?

Foram identificados 11 métodos para coletar dados sobre caça em APs. Cinquenta e nove artigos (53%) utilizaram apenas um método para coletar dados (Tabela 3), enquanto os outros 47% dos trabalhos utilizaram mais de um método para coletar dados que investigassem informações relacionadas a caça.

Tabela 3. Métodos utilizados nos trabalhos para coletar dados sobre caça em áreas protegidas.

Método de coleta de dados	Nº de artigos que utilizaram o método*	Nº de artigos que utilizaram o método como única forma de coleta
Questionamento direto	58	24
Observação direta e indireta de animais	50	14
Dados de outros trabalhos/ Instituição	20	11
Observação direta de caça	14	2
Observação indireta de caça	13	1
Dados de fiscalização/patrulhamento	8	2
Rastreamento de animais com rádio-colar	6	4
"Self-reporting"	5	1
"Randomized Response Technique"	2	0
Mapeamento participativo	1	0
"Unmatched-count Technique"	1	0

* O somatório do número de artigos que utilizaram o método é superior ao número de artigos selecionados nessa revisão (112), pois muitos trabalhos utilizaram mais de um método para coletar dados.

O método mais utilizado para investigar a caça em APs foi o questionamento direto (52% dos trabalhos). Estudos de questionamento direto têm utilizado entrevistas estruturadas e semi-estruturadas, questionários, grupos de discussão e conversas informais para investigar o perfil dos entrevistados, variáveis socioeconômicas (e.g. Bitanyi et al. 2012) e informações relacionadas com a caça, como o consumo de espécies (e.g. Martin et al. 2012), o uso medicinal (e.g. Barros et al. 2012), métodos e armadilhas utilizadas para caçar (e.g. Pereira & Schiavetti 2010) e motivo de estar envolvido na caça legal ou ilegal (e.g. Goldman et al. 2013). Métodos de questionamento direto tiveram como público-alvo comunidades rurais e tradicionais (52%), especificamente caçadores (16%), indígenas (15%), gestores das APs ou funcionários do governo (15%) e operadores de caça esportiva (2%).

A observação direta e indireta da fauna foi realizada em 45% dos trabalhos, principalmente através de transectos e armadilhas fotográficas. Transectos (e.g. Naranjo & Bodmer 2007, Caro et al. 2013, Flesher & Laufer, 2013) e armadilhas fotográficas (e.g. Di Bitetti et al. 2008, Farris et al. 2015) têm sido utilizadas para registrar espécies e estimar sua abundância e densidade. A observação direta de atividades de caça tem sido realizada através da observação participante (e.g. Yasuda 2011, Barros et al. 2012), identificação de carcaças dos animais (e.g. Fa et al. 2006, Merode et al. 2007) e identificação de produtos de animais silvestres comercializados em mercados (e.g. Kaczensky et al. 2008). Com relação às observações indiretas de caça, sinais e vestígios de caça, como armadilhas, acampamentos de caça, sons de tiro e outros, têm sido registrados (e.g. Campbell et al. 2011, Poulsen et al. 2011, Flesher & Laufer 2013).

Autores investigando a caça também utilizaram dados obtidos por outros trabalhos ou por outras Instituições como, por exemplo, dados históricos de distribuição e censo de rinocerontes (*Diceros bicornis*) obtidos através de um programa de monitoramento aéreo no ecossistema do Serengeti-Mara na Tanzânia (Metzger et al 2007), dados de cotas e registros

de abates de leões (*Panthera leo*) e leopardos (*Panthera pardus*) fornecidos pelo CITES da Divisão de Vida Selvagem na Tanzânia (Packer et al 2011) e dados sobre associações com acordos de acesso ao uso de recursos fornecidos pelo Órgão responsável pela Vida Selvagem em Uganda (Mackenzie et al 2011). Dados de fiscalização e patrulhamento foram utilizados em 7% dos trabalhos (e.g. Merode et al. 2007, Jachmann 2008).

O mapeamento participativo tem sido usado para mapear, em colaboração com a comunidade, habitações privadas ou públicas, locais de uso de recursos (caça, pesca, etc.) e atividades em comum (e.g. Bernard et al. 2011). O auto-relato ("self-reporting") é uma técnica na qual o próprio participante registra as informações solicitadas pelo entrevistador. As pessoas têm sido orientadas para completar calendários de dieta, registrando espécies consumidas (e.g. Altrichter 2005) e registrar o peso dos animais caçados, técnicas de caça e duração da caçada (e.g. Ohl-Schacherer et al. 2007).

Técnicas inovadoras, tais como a "Randomized Response Technique" (RRT) e a "Unmatched-count Technique" (UCT) têm sido utilizadas para investigar o uso ilegal de recursos em APs de uso restrito. Ambas tem o objetivo de aumentar a cooperação dos entrevistados em pesquisas que abordem questões comprometedoras ("sensitive questions") ou ilegais. A RRT é uma técnica que utiliza um dispositivo aleatório (como dados ou bolas) para introduzir um elemento de probabilidade no processo de pergunta e resposta (Nuno & St. John 2014), garantindo assim maior confidencialidade para o entrevistado. Já a UCT é uma técnica onde os entrevistados, divididos em dois grupos (tratamento e controle), recebem uma lista de itens onde eles devem identificar quantos itens são aplicados a eles. Enquanto o grupo controle recebe uma lista de itens não comprometedores, o grupo tratamento recebe uma lista com os mesmos itens mais um item comprometedor que é de interesse da pesquisa (Nuno et al. 2013, Nuno & St. John 2014). O uso desses métodos para investigar assuntos relacionados a conservação tem aumentado ao longo da última década. A RRT foi usada para investigar o

consumo ilegal de espécies protegidas por lei (Razafimanahaka et al. 2012) e atividades ilegais incluindo a caça (Solomon et al. 2007), enquanto a UCT foi usada para investigar a caça ilegal dentro e ao redor de APs (Nuno et al. 2013).

3. Quais são as vantagens e desvantagens dos métodos citadas pelos autores?

Em 21 artigos, aspectos positivos e negativos dos métodos utilizados para coletar dados foram citados, fornecendo alguns apontamentos sobre a eficácia das técnicas para obter informações sobre a caça (Tabela 4). Alguns métodos só tiveram observações negativas, mas isso não significa que o método não seja adequado para coleta de dados, mas sim que o uso deste deve ser avaliado com cuidado, com relação a realidade do trabalho proposto, para se obter dados confiáveis. Bitanyi et al. (2012) sugerem que a escolha do delineamento do estudo e de métodos adequados depende do quanto já se sabe sobre o assunto e do tipo de informações que se pretende investigar (comprometedoras ou não).

A maior parte dos aspectos negativos dos métodos estava relacionada a problemas na obtenção de informações sobre a caça ilegal. O questionamento direto, apesar de ser um método amplamente utilizado para investigar a relação pessoa-natureza e ser considerado uma importante abordagem para obter informações sobre o uso de animais silvestres em áreas com pouca fiscalização (Kahindi et al. 2009), pode apresentar desvantagens e resultar em dados tendenciosos quando utilizado para investigar a caça ilegal, especialmente quando não há confiança entre o entrevistado e o entrevistador (Gavin et al. 2010). Por outro lado, as técnicas inovadoras como a RRT e a UCT, têm sido apontadas como alternativas úteis para melhorar a obtenção de informações ilegais, considerando que ambas técnicas obtiveram resultados com maiores estimativas de comportamentos ilegais comparado com os resultados obtidos a partir de questionamento direto (Razafimanahaka et al. 2012, Nuno et al. 2013). Porém aspectos negativos como a necessidade de amostras grandes (Lensvelt-Mulders et al.

2005, Nuno et al. 2013), maior complexidade para explicar o método para os participantes (St. John et al. 2010) e maior complexidade na análise de dados (Nuno et al. 2013) devem ser considerados antes do uso dessas técnicas. Por isso, não há razão para utilizar esses métodos ao investigar um assunto que não seja percebido como ilegal ou comprometedor pelos entrevistados (Razafimanahaka et al. 2012). Considerando a complexidade envolvida na investigação de comportamentos ilegais, Gavin et al. (2010) e Bitanyi et al. (2012) sugerem que a combinação de diferentes técnicas de coleta de dados pode melhorar significativamente a validade das informações.

Tabela 4. Aspectos positivos e negativos dos métodos utilizados para coletar dados sobre caça em áreas protegidas citados pelos autores dos trabalhos.

Método	Aspectos positivos	Aspectos negativos	Referência
Questionamento direto		“Erros de memória podem influenciar dados de consumo de caça”	Golden 2009
		“Relatos de consumo podem ser subestimados porque as pessoas podem hesitar em admitir a caça de espécies protegidas”.	Golden 2009
		"As taxas de não-resposta aumentaram quando as perguntas sobre extração de recursos naturais foram mais diretas".	Mackenzie et al. 2011
		"Apesar da garantia de confidencialidade, foram observadas não-respostas específicas para questões sensíveis”.	Bitanyi et al. 2012
		" Considerando que o consumo de carne de animais silvestres é ilegal, relatos de consumo podem ter sido subestimados”.	Mgawe et al. 2012
		“Residentes rurais em APs estão conscientes da ilegalidade da caça e podem ter fornecido respostas falsas ou incompletas".	Castilho et al. 2013
	“Considerando que a caça ilegal é generalizada e que a lei não é aplicada, optamos por entrevistas, pois esta abordagem tem sido valiosa quando atividades clandestinas podem ser discretamente discutidas com a comunidade”.		MacMillan & Nguyen 2013
		" Respostas falsas e erros de memória podem ter ocorrido por causa da abordagem utilizada ".	Velho & Laurence 2013
		“A proibição da caça pode ter impedido as pessoas de partilhar seus conhecimentos e informações com os pesquisadores”.	Hernandez et al. 2015
		“Menor número de relatos de uso medicinal de animais pode ter ocorrido por percepção de forte controle do governo”.	
Observação direta da fauna		“A baixa visibilidade em florestas tropicais densas geralmente torna as observações diretas de alguns animais muito difíceis, o que leva a fortes subestimativas da densidade dessas espécies”.	Hoppe-Dominik et al. 2011
		“As baixas taxas de encontro de carnívoros pode ser atribuído à colocação de câmeras em trilhas recém-cortadas, dada a ausência de trilhas existentes neste local de floresta contínua”.	Farris et al. 2015
Observação indireta da fauna		“Nem todos os animais deixam vestígios que podem ser contados, o que limita o número de espécies que podem ser pesquisadas, e as estimativas de abundância animal introduzem erros considerando que taxas de produção e decomposição de ninho e fezes são constantes”.	Poulsen et al. 2011

Observação direta de caça		“O número de produtos de animais silvestres comercializados em mercados pode ser superestimado, pois contagens duplas podem ocorrer se os produtos forem negociados dentro dos mercados ou entre os mercados”.	Kaczensky et al. 2008
Dados de fiscalização		"O monitoramento está aberto a três fontes de erro: de natureza técnica, omissões, quer através de negligência ou de propósito, e falsificações".	Jachmann 2008
		“Registros de prisões de patrulhas anti-caça ilegal podem refletir níveis de atividade de caça ilegal, porém, esses dados podem ser enviesados por existência/ ausência de financiamento e qualidade dos esforços”.	Knapp et al. 2010
		“A pressão de caça é particularmente difícil de estimar, dado que os caçadores procuram evitar a detecção por patrulhas”.	Burton et al. 2012
“Unmatched-count Technique” (UCT)	"A UCT forneceu maiores estimativas de comportamento ilegal comparado ao questionamento direto".	"As desvantagens incluem o aumento da complexidade da análise dos dados, a necessidade de amostras maiores, a ocorrência de erros padrão potencialmente maiores, e a limitação dos tipos de perguntas que podem ser utilizadas.	Nuno et al. 2013
“Randomized Response Technique” (RRT)	"A RRT forneceu estimativas mais precisas da utilização ilegal dos recursos pelas populações rurais que residem perto de APs”.	"O processo do desenvolvimento da RRT pode ser confuso e, portanto, erros mecânicos podem ocorrer".	Solomon et al. 2007
		"As respostas poderiam ter sido registradas de forma mais anônima através da RRT, mas a complexidade dessa abordagem teria agravado a potencial sensibilidade das questões relacionadas ao consumo de carne de animais silvestre, cuja ilegalidade não é reconhecida por todos os moradores".	Mgawe et al. 2012
	"A RRT forneceu estimativas mais elevadas de consumo de carne de animais silvestres em uma área onde os entrevistados estavam cientes das leis de proteção da fauna".	"A RRT apresenta desvantagens por necessitar de amostras maiores e por apresentar uma maior complexidade na explicação do processo da entrevista". “Se os entrevistados não se sentirem confortáveis com a técnica ou não entenderem como ela funciona, o uso da RRT não proporcionará a obtenção de estimativas mais acuradas do comportamento investigado”.	Razafimanahaka et al. 2012
“Self-reporting”	“Com base em relações de confiança entre entrevistado e entrevistador, o método continua a ser a única maneira de coletar informações detalhadas de caçadores”.		Knapp 2012
	“Como a caça não é uma atividade ilegal, os participantes estavam abertos para relatar suas atividades de caça”.		Espinosa et al. 2014
Mapeamento participativo	"O método é viável, acessível e eficiente para obter informações sobre como pessoas vivem e utilizam recursos naturais em APs”		Bernard et al. 2011

4. Como os dados sobre caça em APs estão sendo analisados?

Uma grande variedade de métodos foi utilizada para analisar os resultados dos trabalhos (Tabela 5). Dentre os mais usados estão os modelos lineares generalizados (GLM), incluindo modelos logísticos (e.g. Mgawe et al. 2012, Espinosa et al. 2014), modelos mistos (e.g. Golden et al. 2011, Kiffner et al. 2013) e modelos aditivos (e.g. Marchand et al. 2014). Os GLMs são considerados análises potentes que podem ser utilizados para inter-relacionar uma quantidade elevada de variáveis (White et al. 2005). Por exemplo, Martin et al. (2013) utilizaram um GLM para verificar os efeitos da densidade de espécies caçadas, a preferência de habitat e a massa corporal das espécies sobre um índice de preferência de espécies caçadas por caçadores. Já Holmern et al. (2007) utilizaram uma regressão logística para verificar se variáveis como a área de fiscalização, a estação, o número total de caçadores ilegais observados, o número de patrulhas e a existência de suporte recebido para patrulhamento, afetavam a probabilidade de apreender caçadores ilegais.

Tabela 5. Métodos mais utilizados para analisar dados dos trabalhos sobre caça em áreas protegidas.

	Nº de artigos que utilizaram o método
Modelos lineares generalizados	53
ANOVA/Kruskall-Wallis e Teste t/ Mann–Whitney	42
Teste Chi-quadrado	20
Teste de Correlação	18
Análises espaciais (e.g. kernel, Moran’s I)	8
Análise descritiva (porcentagens)	7
Modelo de Sustentabilidade da caça	7
Análises multivariadas (e.g. Análise dos Componentes Principais, análise de Cluster)	6

Além de análises estatísticas mais conhecidas, modelos utilizados para avaliar a sustentabilidade da caça também se destacaram entre os mais usados pelos autores. Por

exemplo, Muchaal e Ngandjui (1999) e Golden (2009) utilizaram o modelo de Robinson & Redford (1991) para estimar a sustentabilidade da caça de espécies através de taxas de abate e produção das espécies. Para calcular as taxas de produção, parâmetros como peso corporal do animal adulto, idade reprodutiva (primeiro e último ano), taxa anual de natalidade de filhotes, dieta e densidade das espécies foram utilizados.

Para analisar dados quantitativos, análises univariadas simples podem ser usadas para investigar a relação entre variáveis, bem como análises mais complexas podem ser usadas para investigar os efeitos de múltiplas variáveis e suas interações (Milner-Gulland & Rowcliffe 2007). A utilização de análises multivariadas e modelos aumentou na ecologia aplicada (White et al. 2005). A crescente disponibilidade de pacotes estatísticos de computação para realizar estes testes sofisticados (Milner-Gulland & Rowcliffe 2007) e tentativas de entender melhor como uma ou mais variáveis resposta estão interligados a variáveis explicativas (Gotelli & Ellison 2004) pode ter causado um maior uso destes métodos. No entanto, a escolha do método de análise adequado vai depender da qualidade dos dados disponíveis e de que perguntas devem ser respondidas (Milner-Gulland & Rowcliffe 2007).

5. O que os autores têm sugerido sobre o controle/ manejo da caça em APs?

Com relação ao manejo e controle da caça em APs, um fator apontado pelos autores dos trabalhos foi a densidade populacional humana que habita o interior ou entorno dessas áreas. Gavin (2007) sugere que a caça sustentável em APs e regimes de manejo adequados só podem ser viáveis quando a população humana que depende do recurso possui baixa densidade. Ikanda & Packer (2008) sugerem que as consequências do contínuo crescimento populacional humano na AP provavelmente irão frustrar até mesmo as estratégias mais eficazes de mitigação da caça causada por retaliação. Ohl-

Schacherer et al. (2007) afirmam que uma das principais políticas de manejo em APs deveria ser a estabilização da população residente. Já Levi et al. (2009) acreditam que negociar limites sobre novos assentamentos em troca de ajuda para o desenvolvimento dos assentamentos já existentes também pode ser uma política complementar para mitigar o problema do aumento populacional em APs.

Na questão de manejo da caça esportiva ("trophy hunting"), Crosmary et al. (2015) mostraram que áreas de caça esportiva podem ser valiosas zonas de conservação para grandes herbívoros quando a remoção dos animais é feita de forma conservadora e rigorosamente controlada. De forma geral, a caça esportiva tem sido considerada essencial para a criação de incentivos econômicos para a conservação dos grandes carnívoros, entretanto, as cotas de abate não podem exceder os níveis sustentáveis para que a conservação da espécie não seja prejudicada (Packer et al. 2011). Por exemplo, em Camarões, Croes et al. (2012) recomendaram uma intervenção temporária imediata com relação ao abate de leões (*Panthera leo)* em áreas de caça para possibilitar a recuperação das populações que estavam sendo criticamente impactadas pela atividade. Loveridge et al. (2007) também recomendaram uma redução das cotas de abate de leões machos em um Parque Nacional no Zimbabwe depois de estudar o impacto que a caça esportiva tem causado na demografia populacional da espécie.

Com relação ao controle da caça por comunidades locais, diversos autores recomendaram o desenvolvimento de programas de educação, buscando melhorar a conscientização das pessoas sobre aspectos da conservação e biodiversidade (e.g. Loibooki et al. 2002, Magige et al. 2009, Castilho et al. 2013). Golden et al (2014) sugerem que a diversificação alimentar através de fontes alternativas de proteína animal podem reduzir a dependência de comunidades locais vivendo no entorno de APs em Madagascar sobre o consumo de animais silvestres. Entretanto, Gardner et al. (2014)

sugerem que incentivar a exploração de fontes de carne alternativas pode ser insuficiente para conter a caça quando a comunidade pratica caça oportunista, pois as pessoas que entram nas florestas para coletar outros recursos continuarão a caçar qualquer animal comestível com que se depararem, pois segundo os moradores da AP Ranobe em Madagascar é "como encontrar dinheiro no chão". Já Amoah & Wiafe (2012) sugerem que a restrição de acesso aos recursos naturais pode não ser a melhor abordagem para conservar a biodiversidade quando fontes alternativas de renda não são disponibilizadas para as comunidades locais. Além disso, Knapp (2012) sugere que se a pobreza é realmente a força motriz da caça ilegal e, densidades populacionais humanas continuarem a crescer, a redução de uma atividade lucrativa como a caça ilegal pode não ocorrer, mesmo que haja maiores esforços na fiscalização.

Para a melhoria do manejo de APs de forma geral, Caro et al. (2013) recomendaram que as autoridades de manejo de APs em todos os países da África deveriam iniciar programas básicos de monitoramento ecológico, coletando dados sobre atividades humanas, e armazenando as informações de forma organizada para auxiliar nas decisões de gestão de curto e longo prazo. Espinosa et al. (2014) mostraram que a colocação de estradas dentro da Reserva da Biosfera de Yasuní no Equador pode reduzir seriamente a capacidade das áreas em sustentar populações de animais silvestres e potencialmente ameaçar a subsistência de grupos indígenas.

Outro importante aspecto que tem trazido crescentes preocupações para os conservacionistas são as consequências das chamadas “florestas vazias” (Redford 1992). Effiom et al. (2014) destacam que espécies de árvores dispersadas por primatas, bem como seus principais agentes de dispersão de sementes, podem ser gravemente reduzidos devido a caça insustentável, e que essa perda de espécies arbóreas pode resultar em uma menor diversidade de recursos alimentares tanto para animais como

para populações humanas. Nunez-Iturri et al. (2008) sugerem que a caça insustentável de mamíferos de grande porte já estar alterando a composição de espécies de plantas em florestas tropicais do Peru e que os efeitos dessa mudança irão ecoar por séculos quando os sub-bosques alterados alcançarem o dossel.

Com relação ao manejo da caça e seus efeitos sobre as populações humanas que dependem do recurso, Golden et al. (2011) mostraram que o consumo de caça está relacionado à saúde de crianças em Madagascar e que a remoção do acesso ao consumo induziria um aumento de crianças sofrendo de anemia. Assim, eles recomendam que formuladores de políticas de conservação e profissionais da saúde devem implementar soluções integradas para atenuar tanto os efeitos da perda de animais silvestres para a saúde e meios de subsistência humana, como os impactos sobre a biodiversidade.

Conclusões

A temática da caça, e a tentativa de investigar fatores que determinem sua sustentabilidade ou não, é um desafio constante para os conservacionistas. Mundialmente, os estudos sobre caça em APs estão aumentando. Há uma preocupação crescente para aumentar os esforços na investigação de comportamentos sensíveis ou ilegais como a caça em APs de uso restrito. A combinação de diferentes técnicas de coleta de dados pode melhorar significativamente a precisão das informações. Além dos métodos mais comumente utilizados, como o questionamento direto, técnicas inovadoras, como a “Randomized Response Technique” e a “Unmatched-count Technique”, têm sido adaptadas e vêm se mostrando promissoras para auxiliar na investigação das informações por fornecerem uma maior segurança e anonimato para os participantes. Cada método para coletar e analisar dados deve ter seus pressupostos respeitados e deve ser dada uma atenção especial para avaliar se a técnica escolhida é

adequada para responder às questões colocadas, e desta forma permitir a obtenção de informações de boa qualidade.

Apesar do número de trabalhos sobre caça em APs ter aumentado nos últimos anos, a falta de informações sobre o uso de recursos, principalmente uso ilegal, tem sido destacada por muitos conservacionistas mundialmente, reforçando a necessidade de aumentar os esforços para a realização de mais pesquisas sobre a caça em APs. A informação confiável é essencial para desenvolver ações eficientes para combater problemas de caça ilegal em APs de proteção integral e manejar a caça legal em zonas de amortecimento e em APs de uso sustentável. O aumento do esforço de pesquisa sobre o assunto irá permitir uma melhor compreensão das causas e efeitos da caça, dos conflitos entre pessoas e animais silvestres e irá fornecer dados de apoio para a elaboração de ações de conservação, tais como o desenvolvimento de um plano de gestão eficaz para APs e espécies ameaçadas (Bruner et al. 2001), enquanto, ao mesmo tempo, poderá auxiliar no desenvolvimento de programas que estimulem o apoio das comunidades locais, através do aumento da conscientização dos moradores e da garantia de subsistência destes (Milner-Gulland & Benett 2003). . Minimizar o impacto dos problemas que envolvem o manejo e controle da caça em APs é um grande desafio que requer o desenvolvimento de ações integradas que busquem tanto a conservação das espécies a longo prazo, como atendam às necessidades de populações humanas que dependem do recurso para sobreviver.

Referências Bibliográficas

ALTRICHTER, M. 2005. The sustainability of subsistence hunting of peccaries in the Argentine Chaco. Biological Conservation 126: 351–362.

AMOAH, M. & WIAFE, E.D. 2012. Livelihoods of fringe communities and the impacts on the management of conservation area: The case of Kakum National Park in Ghana. International Forestry Review 14(2):131-144.

AVERBECK, C., APIO, A., PLATH, M. & WRONSKI, T. 2009. Hunting differentially affects mixed-sex and bachelorherds in a gregarious ungulate, the impala (*Aepyceros melampus*: Bovidae). Afr. J. Ecol. 48:255–264.

BARROS, F.B., VARELA, S.A.M., PEREIRA, H.M. & VICENTE, L. 2012. Medicinal use of fauna by a traditional community in the Brazilian Amazonia**.** Journal of Ethnobiology and Ethnomedicine 8:37.

BENNETT, E., EVES, H., ROBINSON, J. & WILKIE, D. 2002. Why is eating bushmeat a biodiversity crisis? Conservation Biology in Practice 3(1):28–29.

BENNETT, E.L. & ROBINSON, J.G. 2000. Hunting of Wildlife in Tropical Forests: Implications for Biodiversity and Forest Peoples. The WorldBank, Washington, D.C.

BERNARD, E., BARBOSA, L. & CARVALHO, R. 2011. Participatory GIS in a sustainable use reserve in Brazilian Amazonia: Implications for management and conservation. Applied Geography 31:564-572.

BITANYI, S., NESJE, M., KUSILUKA, L.J.M., CHENYAMBUGA, S.W. & KALTENBORN, B.P. 2012. Awareness and perceptions of local people about wildlife hunting in western Serengeti communities. Tropical Conservation Science 5(2):208-224.

BRUNER, A.G., GULLISON R.E., RICE, R.E. & FONSECA, G.A.B. 2001. Effectiveness of Parks in Protecting Tropical Biodiversity. Science 291:125-128.

BURTON, A.C., SAM, M.K., BALANGTAA, C. & BRASHARES, J.S. 2012. Hierarchical multi-species modeling of carnivore responses to hunting, habitat and prey in a west african protected area. PLoS ONE 7(5):e38007.

CAMPBELL, G., KUEHL, H., DIARRASSOUBA, A., N'GORAN, P.K. & BOESCHET, C. 2011. Long-term research sites as refugia for threatened and over-harvested species. Biology Letters 7: 723–726.

CAREY, C., DUDLEY, N. & STOLTON, S. 2000. Squandering paradise? WWF International, Gland, Switzerland.

CARO, T., ELISA, M., GARA, J., KADOMO, D., MARTIN, A., MUSHI, D. & TIMBUKA, C. 2013. Integrating Research with Management: The Case of Katavi National Park, Tanzania. African Zoology 48(1):1-12.

CARVALHO, M., PALMEIRIM, J.M., REGO, F.C., SANTANA, N.S.A. & FA, J.E. 2014. What motivates hunters to target exotic or endemic species on the island of São Tomé, Gulf of Guinea? Oryx doi:10.1017/S0030605313000550.

CASTILHO, L.C., MARTINEZ, R.A., GINÉ, G.A.F., RIBEIRO, G.C. & SCHIAVETTI, A. 2013. The thin-spined porcupine, *Chaetomys subspinosus* (Rodentia: Erethizontidae), within protected areas in the Atlantic Forest, Brazil: local knowledge and threats. Tropical Conservation Science 6(6):796-810.

COLELL, M., MATE, C. & FA, J.E. 1994 .Hunting among Moka Bubis in Bioko: dynamics of fauna1 exploitation at the village level. Biodiversity and Conservation 3:939-950.

CROES, B.M., FUNSTON, P.J., RASMUSSEN, G., BUIJ, R., SALEH, A., TUMENTA, P.N. & IONGH, H.H. 2012. The impact of trophy hunting on lions (*Panthera leo*) and other large carnivores in the Bénoué Complex, northern Cameroon. Biological Conservation 144:3064–3072.

CROSMARY, W.G., CÔTÉ, S.D. & FRITZ, H. 2015. Does trophy hunting matter to long-term population trends in African herbivores of different dietary guilds? Animal Conservation 18:117–130.

CULLEN JR, L., BODMER, E.R. & VALLADARES-PADUA, C. 2001. Ecological consequences of hunting in Atlantic forest patches, São Paulo, Brazil. Oryx 35(1).

DI BITETTI, M.S., PAVIOLO, A., FERRARI, C.A., DE ANGELO, C. & DI BLANCO, Y. 2008. Differential Responses to Hunting in Two Sympatric Species of Brocket Deer (*Mazama americana* and *M. nana*). Biotropica 40(5):636–645.

EFFIOM, E.O., BIRKHOFER, K., SMITH, H.G. & OLSSON, O. 2014. Changes of community composition at multiple trophic levels due to hunting in Nigerian tropical forests. Ecography 37:367–377.

ENDO, W., PERES, C.P., SALAS, E., MORI, S., SANCHEZ-VEGA, J., SHEPARD, G.H., PACHECO, V. & YU, D.W. 2010. Game vertebrate densities in hunted and nonhunted forest sites in Manu National Park, Peru. Biotropica 42(2):251–261.

ESPINOSA, S., BRANCH, L.C. & CUEVA, R. 2014. Road development and the geography of hunting by an amazonian indigenous group: consequences for wildlife conservation. PloS ONE 9(12):e114916.

FA, J.E., SEYMOUR, S., DUPAIN, J., AMIN, R., ALBRECHTSEN, L. & MACDONALD, D. 2006. Getting to grips with the magnitude of exploitation: Bushmeat in the Cross–Sanaga rivers region, Nigeria and Cameroon. Biological Conservation 129(4):497–510.

FARRIS, Z.J., GOLDEN, C.D., KARPANTY, S., MURPHY, A., STAUFFER, D., RATELOLAHY, F., ANDRIANJAKARIVELO, V., HOLMES, C.M. & KELLY, M.J. 2015. Hunting, exotic carnivores, and habitat loss: anthropogenic effects on a native carnivore community, Madagascar. PLoS ONE 10(9):e0136456.

FERNANDES-FERREIRA, H., MENDONÇA, S.V., ALBANO, C., FERREIRA, F.S. & ALVES, R.R.N. 2012. Hunting, use and conservation of birds in Northeast Brazil. Biodiversity and Conservation 21:221–244.

FLESHER, K.M. & LAUFER, J. 2013. Protecting wildlife in a heavily hunted biodiversity hotspot: a case study from the Atlantic Forest of Bahia, Brazil. Tropical Conservation Science 6(2):181-200.

GARDNER, C.J. & DAVIES, Z.G. 2014. Rural bushmeat consumption within multiple-use protected areas: qualitative evidence from Southwest Madagascar. Hum. Ecol. 42:21–34.

GAVIN, M.C. 2007. Foraging in the fallows: Hunting patterns across a successional continuum in the Peruvian Amazon. Biological conservation 134:64–72.

GAVIN, M.C., SOLOMON, J.N. & BLANK, S.G. 2010. Measuring and monitoring illegal use of natural resources. Conservation Biology 24(1):89-100.

GOLDEN, C.D. 2009. Bushmeat hunting and use in the Makira Forest, northeastern Madagascar: a conservation and livelihoods issue. Oryx 43(3):386–392.

GOLDEN, C.D., FERNALD, L.C.H., BRASHARES, J.S., RASOLOFONIAINAD, B.J.R. & KREMEN, C. 2011. Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. PNAS 108(49):19653–19656.

GOLDEN, C.D., WRANGHAM, R.W. & BRASHARES, J.S. 2013. Assessing the accuracy of interviewed recall for rare, highly seasonal events: the case of wildlife consumption in Madagascar. Animal Conservation 16(6):597–603.

GOLDEN, C.D., BONDS, M.H., BRASHARES, J.S., RASOLOFONIAINAD, B.J.R. & KREMEN, C. 2014. Economic valuation of subsistence harvest of wildlife in madagascar. Conservation Biology 28(1):234–243.

GOTELLI, N.J. & ELLISON, A.M. 2004. A primer of ecological statistics. Sinauer Associates, Inc. Sunderland, Massachusetts.

HERNANDEZ, J., CAMPOS, C.M. & BORGHI, C.E. 2015. Medicinal use of wild fauna by mestizo communities living near San Guillermo Biosphere Reserve (San Juan, Argentina). Journal of Ethnobiology and Ethnomedicine 11:15.

HOPPE-DOMINIK, B., KÜHL, H.S., RADL, G. & FISCHER, F. 2011. Long-term monitoring of large rainforest mammals in the Biosphere Reserve of Taı¨ National Park, Côte d'Ivoire. Afr. J. Ecol. 49:450–458.

IKANDA, D. & PACKER, C. 2008. Ritual vs. retaliatory killing of African lions in the Ngorongoro Conservation Area, Tanzania. Endang. Species. Res. 6:67–74.

IUCN. http://www.iucn.org/about/work/programmes/gpap_home/pas_gpap/ (último acesso em 10/12/2014).

JACHMANN, H. 2008. Illegal wildlife use and protected area management in Ghana. Biological Conservation 141:1906–1918.

KACZENSKY, P., ENKHSAIKHAN, N., GANBAATAR, O. & WALZER, C. 2008: The Great Gobi B Strictly Protected Area in Mongolia - refuge or sink for wolves Canis lupus in the Gobi? Wildl. Biol. 14:444-456.

KAHINDI, O., WITTEMYER, G., KING, J., IHWAGI, F., OMONDI, P. & DOUGLAS-HAMILTON, I. 2009. Employing participatory surveys to monitor the illegal killing of elephants across diverse land uses in Laikipia–Samburu, Kenya. African Journal of Ecology 48:972–983.

KIFFNER , C., STONER, C. & CARO, T. 2013. Edge effects and large mammal distributions in a national park. Animal Conservation 16:97–107.

KIRINGE, J.W., OKELLO, M.M. & EKAJUL, S.W. 2007. Managers' perceptions of threats to the protected areas of Kenya: prioritization for effective management. Oryx 41(3):314–321.

KNAPP, E.J., RENTSCH, D., SCHMITT, J., LEWIS, C. & POLASKY, S. 2010. A tale of three villages: choosing an effective method for assessing poaching levels in western Serengeti, Tanzania. Oryx 44(2):178–184.

KNAPP, E. J. 2012. Why poaching pays: a summary of risks and benefits illegal hunters face in Western Serengeti, Tanzania. Tropical Conservation Science 5(4):434-445.

LENSVELT-MULDERS, G., HOX, J., HEIJDEN, P. & MAAS, C. 2005. How to improve the efficiency of randomised response designs. Quality & quantity 39:253-265.

LEVI, T., SHEPARD JR, G.H., OHL-SCHACHERER, J., PERES, C.A. & YU, D.W. 2009. Modelling the long-term sustainability of indigenous hunting in Manu National Park, Peru: landscape-scale management implications for Amazonia. Journal of Applied Ecology 46:804–814.

LEVI, T., SHEPARD JR, G.H., OHL-SCHACHERER, J., WILMERS, C.C., PERES, C.A. & YU, D.W. 2011. Spatial tools for modeling the sustainability of subsistence hunting in tropical forests. Ecological Applications 21(5):1802–1818.

LOIBOOKI, M., HOFER, H., CAMPBELL, K.L.I & EAST, M.L. 2002. Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. Environmental Conservation 29(3):391–398.

LOVERIDGE, A.J., SEARLE A.W., MURINDAGOMO, F. & MACDONALD, D.W. 2007. The impact of sport hunting on the population dynamics of an African lion population in a protected area. Biological Conservation 134:548–558.

MACKENZIE, C.A., CHAPMAN, C.A. & SENGUPTA, R. 2011. Spatial patterns of illegal resource extraction in Kibale National Park, Uganda. Environmental Conservation 39(1):38–50.

MACMILLAN, D.C. & NGUYEN, Q.A. 2013. Factors influencing the illegal harvest of wildlife by trapping and snaring among the Katu ethnic group in Vietnam. Oryx 48(2):304–312.

MAGIGE, F.J., HOLMERN, T., STOKKE, S., MLINGWA, C. & RØSKAFT, E. 2009. Does illegal hunting affect density and behaviour of African grassland birds? A case study on ostrich (*Struthio camelus*). Biodivers. Conserv. 18:1361–1373.

MARCHAND, P., GAREL, M., BOURGOIN, G., DUBRAY, D., MAILLARD, D. & LOISON, A. 2014. Impacts of tourism and hunting on a large herbivore's spatio-temporal behavior in and around a French protected area. Biological Conservation 177.

MARTIN, A., CARO, T., & MULDER, M.B. 2012. Bushmeat consumption in western Tanzania: a comparative analysis from the same ecosystem. Tropical Conservation Science 5(3):352-364.

MERODE, E., SMITH, K.H., HOMEWOOD, K., PETTIFOR, R., ROWCLIFFE, M. & COWLISHAW, G. 2007. The impact of armed conflict on protected-area efficacy in Central Africa. Biology Letters 3:299–301.

MGAWE, P., BORGERHOFF MULDER, M., CARO, T., MARTIN, A. & KIFFNER, C. 2012. Factors affecting bushmeat consumption in the Katavi-Rukwa ecosystem of Tanzania. Tropical Conservation Science 5(4):446-462.

MILNER-GULLAND, E. J. & BENNETT, E. L. 2003. Wild meat: the bigger picture. Trends in Ecology & Evolution 18(7):351-357.

MILNER-GULLAND, E.J. & ROWCLIFFE, J.M. 2007. Conservation and sustainable use. A handbook of techniques. Oxford University Press, New York.

NARANJO, E.J. & BODMER, R.E. 2007. Source–sink systems and conservation of hunted ungulates in the Lacandon Forest, Mexico. Biological Conservation 138:412–420. South African Journal of Wildlife Research 43(2):120-137.

NIELSEN, M.R. & MEILBY, H. 2013. Determinants of compliance with hunting regulations under joint forest management in Tanzania. South African Journal of Wildlife Research 43(2):120-137.

NUNEZ-ITURRI, G. & HOWE, H.F. 2007. Bushmeat and the fate of trees with seeds dispersed by large primates in a lowland rain forest in Western Amazonia. Biotropica 39(3):348–354.

NUNEZ-ITURRI, G., OLSSON, O. & HOWE, H.F. 2008. Hunting reduces recruitment of primate-dispersed trees in Amazonian Peru. Biological Conservation 141:1536–1546.

NUNO, A., BUNNEFELD, N., NAIMAN, L. C. & MILNER-GULLAND, E. J. 2013. A novel approach to assessing the prevalence and drivers of illegal bushmeat hunting in the Serengeti. Conservation Biology 27(6):1355–1365.

NUNO, A. & ST. JOHN, F.A.V. 2015. How to ask sensitive questions in conservation: A review of specialized questioning techniques. Biological Conservation 189:5–15.

OHL-SCHACHERER, J., SHEPARD JR, G. H., KAPLAN, H., PERES, C. A., LEVI, T. AND YU, D. W. 2007. The sustainability of subsistence hunting by Matsigenka native communities in Manu National Park, Peru. Conservation Biology 21(5):1174–1185.

PACKER, C., BRINK, H., KISSUI B. M., MALITI, H., KUSHNIR, H. & CARO, T. 2011. Effects of trophy hunting on lion and leopard populations in Tanzania. Conservation Biology 25(1):142–153.

PEREIRA, J.P.R & SCHIAVETTI, A. Knowledge and faunal game uses by indigenous hunters “Tupinambá from Olivença” (Bahia). Biota Neotrop. 10(1): http://www.biotaneotropica.org.br/v10n1/en/abstract?article+bn03210012010.

PERES, C.A. & NASCIMENTO, H.S. 2006. Impact of game hunting by the Kayapó of southeastern Amazonia: implications for wildlife conservation in tropical forest indigenous reserves. Biodiversity and Conservation 15:2627–2653.

POULSEN, J.R., CLARK, C.J. & BOLKER, B.M. 2011. Decoupling the effects of logging and hunting on an Afrotropical animal community. Ecological Applications 21(5):1819–1836.

RAZAFIMANAHAKA, J., JENKINS, R., ANDRIAFIDISON, D., RANDRIANANDRIANINA, F., RAKOTOMBOAVONJY, V., KEANE, A. & JONES, J.P.G. 2012. Novel approach for quantifying illegal bushmeat consumption reveals high consumption of protected species in Madagascar. Oryx 46(4):584-592.

REDFORD, K.H.1992. The Empty Forest. BioScience 42(6):412-422.

REDFORD, K.H., RAY, J.C. & BOITANI, L. 2011. Mapping and navigating mammalian conservation: from analysis to action. Phil. Trans. R. Soc. B 366:2712–2721.

ROBINSON, J. G. & REDFORD, K. H. 1991. Sustainable harvest of Neotropical wildlife. In Neotropical wildlife use and conservation (J. G. Robinson & K. H. Redford, eds.). University of Chicago Press, Chicago, p.415–429

SOLOMON, J., JACOBSON, S.K, WALD, K.D. & GAVIN, M. 2007. Estimating illegal resource use at a Ugandan Park with the Randomized Response Technique. Human Dimensions of Wildlife 12:75-88.

ST. JOHN, F.A.V., EDWARDS-JONES, G., GIBBONS, J.M. & JONES, J.P.G. 2010. Testing novel methods for assessing rule breaking in conservation. Biological Conservation 143:1025-1030.

TOPP-JØRGENSEN, E., NIELSEN, M.R., MARSHALL, A.R. & PEDERSEN, U. 2009. Relative densities of mammals in response to different levels of bushmeat hunting in the Udzungwa Mountains, Tanzania. Tropical Conservation Science 2(1):70-87.

VELHO, N. & LAURENCE, W.F. 2013. Hunting practices of an Indo-Tibetan Buddhist tribe in Arunachal Pradesh, northeast India. Oryx 47(3):389–392.

WHITE, P.C.L., JENNINGS, N.V., RENWICK, A.R., BARKER, N.H.L. 2005. Questionnaires in ecology: a review of past use and recommendations for best practice. Journal of Applied Ecology 42:421-430.

WRIGHT, S. J., STONER, K. E., BECKMAN, N., CORLETT, R.T., DIRZO, R., MULLER-LANDAU, H.C., NUNEZ-ITURRI, G., PERES, C.A. & WANG, B.C. 2007. The plight of large animals in tropical forests and the consequences for plant regeneration. Biotropica 39(3):289-291.

YASUDA, A. 2011. The impacts of sport hunting on the livelihoods of local people: A case study of Bénoué National Park, Cameroon. Society and Natural Resources 24(8):860-869.

Material Suplementar

Lista dos 112 artigos selecionados para a revisão

ALTRICHTER, M. 2005. The sustainability of subsistence hunting of peccaries in the Argentine Chaco. Biological Conservation 126: 351–362.

AMOAH, M. & WIAFE, E.D. 2012. Livelihoods of fringe communities and the impacts on the management of conservation area: The case of Kakum National Park in Ghana. International Forestry Review 14(2):131-144.

AVERBECK, C., APIO, A., PLATH, M. & WRONSKI, T. 2009. Hunting differentially affects mixed-sex and bachelorherds in a gregarious ungulate, the impala (*Aepyceros melampus*: Bovidae). Afr. J. Ecol. 48:255–264.

BARROS, F.B., VARELA, S.A.M., PEREIRA, H.M. & VICENTE, L. 2012. Medicinal use of fauna by a traditional community in the Brazilian Amazonia**.** Journal of Ethnobiology and Ethnomedicine 8:37.

BERNARD, E., BARBOSA, L. & CARVALHO, R. 2011. Participatory GIS in a sustainable use reserve in Brazilian Amazonia: Implications for management and conservation. Applied Geography 31:564-572.

BITANYI, S., NESJE, M., KUSILUKA, L.J.M., CHENYAMBUGA, S.W. & KALTENBORN, B.P. 2012. Awareness and perceptions of local people about wildlife hunting in western Serengeti communities. Tropical Conservation Science 5(2):208-224.

BITTY, A.E., GONEDELE, S.B., KOFFI BENE, J.C., KOUASS, P.Q.I & MCGRAW, W.S. 2015. Cocoa farming and primate extirpation inside Cote d'Ivoire's protected areas. Tropical Conservation Science 8(1): 95-113.

BLOM, A., ZALINGE, R., HEITKÖNIG, I.M.A. & PRINS, H.H.T. 2005. Factors influencing the distribution of large mammals within a protected central African forest. Oryx 39(4): 381–388.

BURTON, A.C., SAM, M.K., BALANGTAA, C. & BRASHARES, J.S. 2012. Hierarchical multi-species modeling of carnivore responses to hunting, habitat and prey in a west african protected area. PLoS ONE 7(5):e38007.

CAMPBELL, G., KUEHL, H., DIARRASSOUBA, A., N'GORAN, P.K. & BOESCHET, C. 2011. Long-term research sites as refugia for threatened and over-harvested species. Biology Letters 7: 723–726.

CARO, T., ELISA, M., GARA, J., KADOMO, D., MARTIN, A., MUSHI, D. & TIMBUKA, C. 2013. Integrating Research with Management: The Case of Katavi National Park, Tanzania. African Zoology 48(1):1-12.

CARVALHO JR, E.A.R & MORATO, R.G. 2013. Factors affecting big cat hunting in Brazilian protected areas. Tropical Conservation Science 6(2):303-310.

CASTILHO, L.C., MARTINEZ, R.A., GINÉ, G.A.F., RIBEIRO, G.C. & SCHIAVETTI, A. 2013. The thin-spined porcupine, *Chaetomys subspinosus* (Rodentia: Erethizontidae), within protected areas in the Atlantic Forest, Brazil: local knowledge and threats. Tropical Conservation Science 6(6):796-810.

CHAN, H., SHOEMAKER, K.T. & KARRAKER, N.E. 2014. Demography of Quasipaa frogs in China reveals high vulnerability to widespread harvest pressure. Biological Conservation 170: 3–9.

COLELL, M., MATE, C. & FA, J.E. 1994 .Hunting among Moka Bubis in Bioko: dynamics of fauna1 exploitation at the village level. Biodiversity and Conservation 3:939-950.

CROES, B.M., FUNSTON, P.J., RASMUSSEN, G., BUIJ, R., SALEH, A., TUMENTA, P.N. & IONGH, H.H. 2012. The impact of trophy hunting on lions (*Panthera leo*) and other large carnivores in the Bénoué Complex, northern Cameroon. Biological Conservation 144:3064–3072.

CROSMARY, W.G., CÔTÉ, S.D. & FRITZ, H. 2015. Does trophy hunting matter to long-term population trends in African herbivores of different dietary guilds? Animal Conservation 18:117–130.

CULLEN JR, L., BODMER, E.R. & VALLADARES-PADUA, C. 2001. Ecological consequences of hunting in Atlantic forest patches, São Paulo, Brazil. Oryx 35(1).

DI BITETTI, M.S., PAVIOLO, A., FERRARI, C.A., DE ANGELO, C. & DI BLANCO, Y. 2008. Differential Responses to Hunting in Two Sympatric Species of Brocket Deer (*Mazama americana* and *M. nana*). Biotropica 40(5):636–645.

DJAGOUN, C.A.M.S., KASSA, B., DJOSSA, B.A., COULSON, T., MENSAH, G.A. & SINSIN, B. 2014. Hunting affects dry season habitat selection by several bovid species in northern Benin. Wildlife Biology 20(2):83-90.

EFFIOM, E.O., BIRKHOFER, K., SMITH, H.G. & OLSSON, O. 2014. Changes of community composition at multiple trophic levels due to hunting in Nigerian tropical forests. Ecography 37:367–377.

ENDO, W., PERES, C.P., SALAS, E., MORI, S., SANCHEZ-VEGA, J., SHEPARD, G.H., PACHECO, V. & YU, D.W. 2010. Game vertebrate densities in hunted and nonhunted forest sites in Manu National Park, Peru. Biotropica 42(2):251–261.

ESPINOSA, S., BRANCH, L.C. & CUEVA, R. 2014. Road development and the geography of hunting by an amazonian indigenous group: consequences for wildlife conservation. PloS ONE 9(12):e114916.

FA, J.E., SEYMOUR, S., DUPAIN, J., AMIN, R., ALBRECHTSEN, L. & MACDONALD, D. 2006. Getting to grips with the magnitude of exploitation: Bushmeat in the Cross–Sanaga rivers region, Nigeria and Cameroon. Biological Conservation 129(4):497–510.

FARRIS, Z.J., GOLDEN, C.D., KARPANTY, S., MURPHY, A., STAUFFER, D., RATELOLAHY, F., ANDRIANJAKARIVELO, V., HOLMES, C.M. & KELLY, M.J.

2015. Hunting, exotic carnivores, and habitat loss: anthropogenic effects on a native carnivore community, Madagascar. PLoS ONE 10(9):e0136456.

FERRERAS, P., ALDAMA, J.J., BELTRÁN, J. F. & DELIBES, M.. 1992. Rates and causes of mortality in a fragmented population of Iberian lynx Felis pardina Temminck, 1824. Biological Conservation 61:197-202.

FITZHERBERT, E., CARO, T., JOHNSON, P.J., MACDONALD, D.W. & BORGERHOFF MULDER, M. 2014. From avengers to hunters: Leveraging collective action for the conservation of endangered lions. Biological Conservation 174:84–92.

FLESHER, K.M. & LAUFER, J. 2013. Protecting wildlife in a heavily hunted biodiversity hotspot: a case study from the Atlantic Forest of Bahia, Brazil. Tropical Conservation Science 6(2):181-200.

FOERSTER, S., WILKIE, D.S., MORELLI, G.A., DEMMER, J., STARKEY, M., TELFER, P., STEIL, M. & LEWBEL, A. 2011. Correlates of Bushmeat Hunting among Remote Rural Households in Gabon, Central Africa. Conservation Biology 26(2):335-344.

FOUSSENI, F., MARRA, D., WALA, K., BATAWILA, K., ZHANG, C., ZHAO, X. & AKPAGANA, K. 2012. Assessment and impact of anthropogenic disturbances in protected areas of northern Togo. For. Stud. China 14(3): 216–223.

GANDIWA, E. 2011. Preliminary assessment of illegal hunting by communities adjacent to the northern Gonarezhou National Park, Zimbabwe. Tropical Conservation Science 4(4):445-467.

GANDIWA, E., HEITKÖNIG, I.M.A., LOKHORST, A.M., PRINS, H.H.T., LEEUWIS, C. 2013. Illegal hunting and law enforcement during a period of economic decline in Zimbabwe: A case study of northern Gonarezhou National Park and adjacent areas. Journal for Nature Conservation 21(3):133–142.

GARDNER, C.J. & DAVIES, Z.G. 2014. Rural bushmeat consumption within multiple-use protected areas: qualitative evidence from Southwest Madagascar. Hum. Ecol. 42:21–34.

GAVIN, M.C. 2007. Foraging in the fallows: Hunting patterns across a successional continuum in the Peruvian Amazon. Biological conservation 134:64–72.

GOLDEN, C.D. 2009. Bushmeat hunting and use in the Makira Forest, northeastern Madagascar: a conservation and livelihoods issue. Oryx 43(3):386–392.

GOLDEN, C.D., FERNALD, L.C.H., BRASHARES, J.S., RASOLOFONIAINAD, B.J.R. & KREMEN, C. 2011. Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. PNAS 108(49):19653–19656.

GOLDEN, C.D., WRANGHAM, R.W. & BRASHARES, J.S. 2013. Assessing the accuracy of interviewed recall for rare, highly seasonal events: the case of wildlife consumption in Madagascar. Animal Conservation 16(6):597–603.

GOLDEN, C.D., BONDS, M.H., BRASHARES, J.S., RASOLOFONIAINAD, B.J.R. & KREMEN, C. 2014. Economic valuation of subsistence harvest of wildlife in madagascar. Conservation Biology 28(1):234–243.

GREENGRASS, E.J. 2009. Chimpanzees are Close to Extinction in Southwest Nigeria. Primate Conservation 24:77-83.

GRIGNOLIO, S., MERLI, E., BONGI, P., CIUTI, S. & APOLLONIO, M. 2011. Effects of hunting with hounds on a non-target species living on the edge of a protected area. Biological Conservation 144: 641–649.

GUARIGUATA, M.R ADAME, J.J.R. & FINEGAN, B. 2000. Seed Removal and Fate in Two Selectively Logged Lowland Forests with Constrasting Protection Levels. Conservation Biology 14(4):1046–1054.

HAYWARD, M.W. 2009. Bushmeat Hunting in Dwesa and Cwebe Nature Reserves, Eastern Cape, South Africa. South African Journal of Wildlife Research 39(1):70-84.

HAZZAH, L., DOLRENRY, S., KAPLAN, D. & FRANK, L. 2013. The influence of park access during drought on attitudes toward wildlife and lion killing behaviour in Maasailand, Kenya. Environmental Conservation 40(3): 266–276.

HENSCHEL, P., HUNTER, L.T.B., COAD, L., ABERNETHY, K.A. & MÜHLENBERG, M. 2011. Leopard prey choice in the Congo Basin rainforest suggests exploitative competition with human bushmeat hunters. Journal of Zoology 285:11–20.

HERNANDEZ, J., CAMPOS, C.M. & BORGHI, C.E. 2015. Medicinal use of wild fauna by mestizo communities living near San Guillermo Biosphere Reserve (San Juan, Argentina). Journal of Ethnobiology and Ethnomedicine 11:15.

HOLM, T.E., LAURSEN, K. & CLAUSEN, P. 2011. The feeding ecology and distribution of Common Coots Fulica atra are affected by hunting taking place in adjacent areas. Bird Study 58(3): 321-329.

HOLMERN, T., MUYA, J. & RØSKAFT, E. 2007. Local law enforcement and illegal bushmeat hunting outside the Serengeti National Park, Tanzania. Environmental Conservation 34(1):55–63.

HOPPE-DOMINIK, B., KÜHL, H.S., RADL, G. & FISCHER, F. 2011. Long-term monitoring of large rainforest mammals in the Biosphere Reserve of Taı¨ National Park, Côte d'Ivoire. Afr. J. Ecol. 49:450–458.

IKANDA, D. & PACKER, C. 2008. Ritual vs. retaliatory killing of African lions in the Ngorongoro Conservation Area, Tanzania. Endang. Species. Res. 6:67–74.

JACHMANN, H. 2008. Illegal wildlife use and protected area management in Ghana. Biological Conservation 141:1906–1918.

KACZENSKY, P., ENKHSAIKHAN, N., GANBAATAR, O. & WALZER, C. 2008: The Great Gobi B Strictly Protected Area in Mongolia - refuge or sink for wolves Canis lupus in the Gobi? Wildl. Biol. 14:444-456.

KALTENBORN, B.P., NYAHONGO, J.W. & TINGSTAD, K.M. 2005. The nature of hunting around the Western Corridor of Serengeti National Park, Tanzania. Eur J Wildl Res 51:213–222.

KIFFNER, C., STONER, C. & CARO, T. 2013. Edge effects and large mammal distributions in a national park. Animal Conservation 16:97–107.

KIRINGE, J.W., OKELLO, M.M. & EKAJUL, S.W. 2007. Managers' perceptions of threats to the protected areas of Kenya: prioritization for effective management. Oryx 41(3):314–321.

KNAPP, E.J., RENTSCH, D., SCHMITT, J., LEWIS, C. & POLASKY, S. 2010. A tale of three villages: choosing an effective method for assessing poaching levels in western Serengeti, Tanzania. Oryx 44(2):178–184.

KNAPP, E. J. 2012. Why poaching pays: a summary of risks and benefits illegal hunters face in Western Serengeti, Tanzania. Tropical Conservation Science 5(4):434-445.

KUEHL, H.S., NZEINGUI, C., YENO, S.L.D., HUIJBREGTS, B., BOESCH, C. & WALSH, P.D. 2009. Discriminating between village and commercial hunting of apes. Biological Conservation 142:1500–1506.

LEVI, T., SHEPARD JR, G.H., OHL-SCHACHERER, J., PERES, C.A. & YU, D.W. 2009. Modelling the long-term sustainability of indigenous hunting in Manu National Park, Peru: landscape-scale management implications for Amazonia. Journal of Applied Ecology 46:804–814.

LEVI, T., SHEPARD JR, G.H., OHL-SCHACHERER, J., WILMERS, C.C., PERES, C.A. & YU, D.W. 2011. Spatial tools for modeling the sustainability of subsistence hunting in tropical forests. Ecological Applications 21(5):1802–1818.

LINDER, J.M. & OATES, J.F. 2011. Differential impact of bushmeat hunting on monkey species and implications for primate conservation in Korup National Park, Cameroon. Biological Conservation 144:738–745.

LINDSEY, P.A., ROMAÑACH, S.S., TAMBLING, C.J., CHARTIER, K.& GROOM, R. 2011. Ecological and financial impacts of illegal bushmeat trade in Zimbabwe. Oryx 45(1):96–111.

LOIBOOKI, M., HOFER, H., CAMPBELL, K.L.I & EAST, M.L. 2002. Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. Environmental Conservation 29(3):391–398.

LOVERIDGE, A.J., SEARLE A.W., MURINDAGOMO, F. & MACDONALD, D.W. 2007. The impact of sport hunting on the population dynamics of an African lion population in a protected area. Biological Conservation 134:548–558.

MACHADO, N. & LOYOLA, R.D. 2013. A Comprehensive Quantitative Assessment of Bird Extinction Risk in Brazil. PLoS ONE 8(8): e72283.

MACKENZIE, C.A., CHAPMAN, C.A. & SENGUPTA, R. 2011. Spatial patterns of illegal resource extraction in Kibale National Park, Uganda. Environmental Conservation 39(1):38–50.
MACMILLAN, D.C. & NGUYEN, Q.A. 2013. Factors influencing the illegal harvest of wildlife by trapping and snaring among the Katu ethnic group in Vietnam. Oryx 48(2):304–312.

MAGIGE, F.J., HOLMERN, T., STOKKE, S., MLINGWA, C. & RØSKAFT, E. 2009. Does illegal hunting affect density and behaviour of African grassland birds? A case study on ostrich (*Struthio camelus*). Biodivers. Conserv. 18:1361–1373.

MAMMIDES, C., KADIS, C. & COULSON, T. 2015. The effects of road networks and habitat heterogeneity on the species richness of birds in Natura 2000 sites in Cyprus. Landscape Ecol 30:67–75.

MARCHAND, P., GAREL, M., BOURGOIN, G., DUBRAY, D., MAILLARD, D. & LOISON, A. 2014. Impacts of tourism and hunting on a large herbivore's spatio-temporal behavior in and around a French protected area. Biological Conservation 177.

MARTIN, A., CARO, T., & MULDER, M.B. 2012. Bushmeat consumption in western Tanzania: a comparative analysis from the same ecosystem. Tropical Conservation Science 5(3):352-364.

MARTIN, A., CARO, T. & KIFFNER, C. 2013. Prey preferences of bushmeat hunters in an East African savannah ecosystem. Eur J Wildl Res 59:137–145.

MCLOUGHLIN, P.D., WAL, E.V., LOWE, S.J., PATTERSON, B.R. & MURRAY, D.L. 2011. Seasonal shifts in habitat selection of a large herbivore and the influence of human activity. Basic and Applied Ecology 12:654–663.

MERODE, E., SMITH, K.H., HOMEWOOD, K., PETTIFOR, R., ROWCLIFFE, M. & COWLISHAW, G. 2007. The impact of armed conflict on protected-area efficacy in Central Africa. Biology Letters 3:299–301.

METZGER, K.L., SINCLAIR, A.R.E., CAMPBELL, K.L.I., HILBORN, R., HOPCRAFT, J.G.C., MDUMA, S.A.R. & REICH, R.M. 2007. Using historical data to establish baselines for conservation: The black rhinoceros (Diceros bicornis) of the Serengeti as a case study. Biological Conservation 139:358 –374.

METZGER, K.L., SINCLAIR, A.R.E., HILBORN, R., HOPCRAFT, J.G.C. & MDUMA, S.A.R. 2010. Evaluating the protection of wildlife in parks: the case of African buffalo in Serengeti. Biodivers Conserv 19:3431–3444.

MFUNDA, I.M. & ROSKAFT, E. 2010. Bushmeat hunting in Serengeti, Tanzania: An important economic activity to local people. International Journal of Biodiversity and Conservation 2(9):263-272.

MGAWE, P., BORGERHOFF MULDER, M., CARO, T., MARTIN, A. & KIFFNER, C. 2012. Factors affecting bushmeat consumption in the Katavi-Rukwa ecosystem of Tanzania. Tropical Conservation Science 5(4):446-462.

MUCHAAL, P.K. & NGANDJUI, G. 1999. Impact of Village Hunting on Wildlife Populations in the Western Dja Reserve, Cameroon. Conservation Biology 13(2):385–396.

MURAI, M., RUFFLER, H., BERLEMONT, A., CAMPBELL, G., ESONO, F., AGBOR, A., MBOMIO, D., EBANA, A., NZE, A. & KÜHL, H.S. 2013 Priority Areas for Large Mammal Conservation in Equatorial Guinea. PLoS ONE 8(9):e75024.

NARANJO, E.J. & BODMER, R.E. 2007. Source–sink systems and conservation of hunted ungulates in the Lacandon Forest, Mexico. Biological Conservation 138:412–420. South African Journal of Wildlife Research 43(2):120-137.

NAUGHTON-TREVES, L., MENA, J.L., TREVES, A., ALVAREZ, N. & RADELOFF, V.C. 2003. Wildlife Survival Beyond Park Boundaries: the Impact of Slash-and-Burn Agriculture and Hunting on Mammals in Tambopata, Peru. Conservation Biology 17(4):1106–1117.

NIELSEN, M.R. & MEILBY, H. 2013. Determinants of compliance with hunting regulations under joint forest management in Tanzania. South African Journal of Wildlife Research 43(2):120-137.

NOSS, A.J., OETTING, I. & CUÉLLAR, R.L. 2005. Hunter self-monitoring by the Isoseño-Guaraní in the Bolivian Chaco. Biodiversity and Conservation 14:2679–2693.

NUNEZ-ITURRI, G. & HOWE, H.F. 2007. Bushmeat and the fate of trees with seeds dispersed by large primates in a lowland rain forest in Western Amazonia. Biotropica 39(3):348–354.

NUNEZ-ITURRI, G., OLSSON, O. & HOWE, H.F. 2008. Hunting reduces recruitment of primate-dispersed trees in Amazonian Peru. Biological Conservation 141:1536–1546.

NUNO, A., BUNNEFELD, N., NAIMAN, L. C. & MILNER-GULLAND, E. J. 2013. A novel approach to assessing the prevalence and drivers of illegal bushmeat hunting in the Serengeti. Conservation Biology 27(6):1355–1365.

NYAHONGO, J.W., EAST, M.L., MTURI, F.A. & HOFER, H. 2005. Benefits and costs of illegal grazing and hunting in the Serengeti ecosystem. Environmental Conservation 32(4): 326–332.

OHL-SCHACHERER, J., SHEPARD JR, G. H., KAPLAN, H., PERES, C. A., LEVI, T. AND YU, D. W. 2007. The sustainability of subsistence hunting by Matsigenka native communities in Manu National Park, Peru. Conservation Biology 21(5):1174–1185.

PACKER, C., BRINK, H., KISSUI B. M., MALITI, H., KUSHNIR, H. & CARO, T. 2011. Effects of trophy hunting on lion and leopard populations in Tanzania. Conservation Biology 25(1):142–153.

PEREIRA, J.P.R & SCHIAVETTI, A. Knowledge and faunal game uses by indigenous hunters “Tupinambá from Olivença” (Bahia). Biota Neotrop. 10(1): http://www.biotaneotropica.org.br/v10n1/en/abstract?article+bn03210012010.

POULSEN, J.R., CLARK, C.J. & BOLKER, B.M. 2011. Decoupling the effects of logging and hunting on an Afrotropical animal community. Ecological Applications 21(5):1819–1836.

RAO, M., HTUN, S., ZAW, T. & MYINT, T. 2010. Hunting, Livelihoods and Declining Wildlife in the Hponkanrazi Wildlife Sanctuary, North Myanmar. Environmental Management 46(2): 143-153.

RAZAFIMANAHAKA, J., JENKINS, R., ANDRIAFIDISON, D., RANDRIANANDRIANINA, F., RAKOTOMBOAVONJY, V., KEANE, A. & JONES, J.P.G. 2012. Novel approach for quantifying illegal bushmeat consumption reveals high consumption of protected species in Madagascar. Oryx 46(4):584-592.

REYNA-HURTADO, R., NARANJO, E., CHAPMAN, C.A. & TANNER, G.W. 2009. Hunting and the conservation of a social ungulate: the white-lipped peccary Tayassu pecari in Calakmul, Mexico. Oryx 44(1):89–96.

REYNA-HURTADO, R. & TANNER, G.W. 2007. Ungulate relative abundance in hunted and non-hunted sites in Calakmul Forest (Southern Mexico). Biodiversity and Conservation 16:743–756.

SANTILLI, F. & BAGLIACCA, M. 2008. Factors influencing pheasant Phasianus colchicus harvesting in Tuscany, Italy. Wildlife Biology 14(3):281-287.

SHEPARD JR., G.H., LEVI, T., NEVES, E.G., PERES, C.A. & YU, D.W. 2012. Hunting in Ancient and Modern Amazonia: Rethinking Sustainability. American Anthropologist 114(4): 652–667.

SILVA, M.J.F., GODINHO, R., CASANOVA, C., MINHÓS, T., SÁ, R. & BRUFORD, M.W. 2014. Assessing the impact of hunting pressure on population structure of Guinea baboons (*Papio papio*) in Guinea-Bissau. Conserv Genet 15:1339–1355.

SKONHOFT, A., YOCCOZ, N.G., STENSETH, N.C., GAILLARD, J. & LOISON, A. 2002. Management of Chamois (*Rupicapra rupicapra*) Moving between a Protected Core Area and a Hunting Area. Ecological Applications 12(4):1199-1211.

SOLOMON, J., JACOBSON, S.K, WALD, K.D. & GAVIN, M. 2007. Estimating illegal resource use at a Ugandan Park with the Randomized Response Technique. Human Dimensions of Wildlife 12:75-88.

TARAKINI, T., CROSMARY, W., FRITZ, H. & MUNDY, P. 2014. Flight Behavioural Responses to Sport Hunting by Two African Herbivores. South African Journal of Wildlife Research 44(1):76-83.

THIBAULT, M. & BLANEY, S. 2003. The oil industry as an underlying factor in the bushmeat crisis in Central Africa. Conservation Biology 17(6):1807-1813.

THOISY, B., RENOUX, F. & JULLIOT, C. 2005. Hunting in northern French Guiana and its impact on primate communities. Oryx 39(2): 149–157.

TRANQUILLI, S., ABEDI-LARTEY, M., ABERNETHY, K., AMSINI, F., ASAMOAH, A., et al. 2014. Protected Areas in Tropical Africa: Assessing Threats and Conservation Activities. PLoS ONE 9(12): e114154.

VELATTA, F. 2013. Hunting effects on Bird communities: the case of the province of Perugia. Avocetta 37: 43-60.

VELHO, N. & LAURENCE, W.F. 2013. Hunting practices of an Indo-Tibetan Buddhist tribe in Arunachal Pradesh, northeast India. Oryx 47(3):389–392.

WALTERT, M., FABER, K., & MÜHLENBERG, M. 2002. Further declines of threatened primates in the Korup Project Area, south-west Cameroon. Oryx 36(03): 257-265.

WALKER, R.C.J. & RAFELIARISOA, T.H. 2012. Distribution of Radiated Tortoise (*Astrochelys radiata*) Bush Meat Poaching Effort. Chelonian Conservation and Biology 11(2):223-226.

WILFRED, P. & MACCOLL, A. 2014a. Legal subsistence hunting trends in the Ugalla ecosystem of western Tanzania. Eur J Wildl Res 60:371–376.

WILFRED, P. & MACCOLL, A. 2014b. The pattern of poaching signs in Ugalla Game Reserve, western Tanzania. African Journal of Ecology 52(4):543–551.

WILLCOX, A.S. & NAMBU, D.M. 2007. Wildlife hunting practices and bushmeat dynamics of the Banyangi and Mbo people of Southwestern Cameroon. Biological Conservation 134: 251–261.

YASUDA, A. 2011. The impacts of sport hunting on the livelihoods of local people: A case study of Bénoué National Park, Cameroon. Society and Natural Resources 24(8):860-869.

CAPÍTULO 2

HUNTING OF MAMMAL SPECIES IN AND AROUND PROTECTED AREAS OF THE NORTHEASTERN ATLANTIC FOREST, BRAZIL

(Manuscrito formatado nas normas da revista Biodiversity and Conservation)

Hunting of mammal species in and around Protected Areas of the northeastern Atlantic Forest, Brazil

Abstract

Hunting is a major threat to wildlife in Brazilian Protected Areas and species, including the threatened ones, have been killed for consumption, trade or retaliation. This study aimed to provide information to the National Action Plan for conservation of the Central Atlantic Forest mammals, by investigating how rural people are using wildlife in protected areas in southern Bahia and which species are the most consumed, with a focus on threatened mammals. A total of 169 direct interviews and 182 interviews using the Randomized Response Technique were performed with rural residents living in three protected areas and a buffer zone. Thirty seven percent of respondents declared to hunt opportunistically, 16% to hunt actively and 47% of residents declared not to hunt. The major motivation for hunting was consumption, but people also hunt for medicinal purposes, recreation and retaliation. Hunting was significantly related to level of formal education, with primary education respondents hunting more. We found that estimates of consumption were higher for species such as *Cuniculus paca*, *Dasypus novemcinctus* and *Pecari tajacu*. Meanwhile the proportion of consumption for threatened species was low. Our study suggests there is widespread hunting within the PAs, but that people mostly want to hunt common species for their own consumption. In these circumstances, it is necessary to take an approach to wildlife management that involves local people, so that wildlife is conserved and the welfare of residents is enhanced. This could include an expanded education program, investing in diversifying livelihood activities and protein sources, besides improving law enforcement.

Introduction

Hunting in tropical forests provides a source of nutrition (Fa et al. 2002) and income for local communities and is also deeply rooted in social and cultural traditions (Bennett and Robinson 2000; Van Vliet 2011). However, in recent decades wildlife harvest has reached unsustainable rates in many places because of the growing human population and increased demand for wild meat (Peres 2000; Bennett et al. 2002), the advancement of hunting technologies and increased access to forests (Bennett et al. 2002; Fa and Brown 2009). Besides causing populations declines or even extinction of species (Cullen Jr et al. 2000; Corlett 2007; Peres and Palacios 2007), overhunting can impact the ecological functionality of ecosystems (Cullen Jr et al. 2001; Wright et al. 2007; Peres et al. 2016) and can affect local communities that depend on the consumption of wild meat for subsistence (Milner-Gulland and Bennett 2003). Consequently, unsustainable hunting is a major concern both for wildlife conservation and with respect to the wellbeing of the people that subsist on wild meat (Redford 1992; Milner-Gulland and Bennett 2003; Levi et al. 2011; Nasi et al. 2011). With respect to social and economic aspects, hunting has been correlated with factors such as wealth, level of education, household size (Foerster et al. 2012), income, livestock ownership (Loibooki et al. 2002) and age (Melo et al. 2014).

In Brazil, hunting is an illegal activity, except in a case of necessity to satisfy the hunger of a person. Penalties are more severe for hunting inside protected areas (PAs) and hunting of threatened species (Art. 29 Federal Law 9605/98 - Law of Environmental Crimes). Despite the law, hunting is widespread in Brazil (Carvalho Jr and Morato 2013; El Bizri et al. 2015) and has been cited as a major threat to wildlife in the PAs of the Atlantic Forest (Chiarello 2000; Schiavetti et al. 2012; Canale et al. 2012), Amazon (Carvalho and Pezzuti 2010) and other regions of northeastern Brazil

(Fernandes-Ferreira et al. 2012; Fernandes-Ferreira et al. 2013). Subsistence is the main reason for hunting, particularly in indigenous and traditional communities (Peres and Nascimento 2006; Hanazaki et al. 2009; Barbosa et al. 2011; Minzenberg and Wallace 2011). However, recreational activity and trade are also motivations for hunting (Chiarello 2000; Alves et al. 2009; Fernandes-Ferreira et al. 2012). Species, particularly the threatened ones, have been killed for consumption (Castilho et al. 2013; Melo et al. 2014; Morcatty and Valsecchi 2015), traditional medicine (Alves 2009; Ribeiro et al. 2010), the pet trade (Fernandes-Ferreira et al. 2012; Nascimento et al. 2013) or retaliation (Carvalho Jr and Morato 2013), that occurs when a person kills an animal because it caused damage or costs to him

In an attempt to mitigate threats to endangered species in Brazil, National Action Plans have been developed to identify and prioritize conservation actions (ICMBio 2014). The Atlantic Forest receives special attention because it is considered a hotspot of global biodiversity (Myers et al. 2000; Tabarelli et al. 2005). Of the 250 mammal species occurring in the Atlantic Forest, 39 are at risk of extinction (ICMBio 2010). Major threats for species of the Atlantic Forest are the growing human population and associated activities (deforestation, hunting, roads, illegal wildlife traffic, wood extraction, pollution, etc. (ICMBio 2010)). In 2010, a National Action Plan (NAP) was created to protect threatened mammals of the Central Atlantic Forest, with the aim of increasing the population viability of its target species, reverse population declines and increase the extent, connectivity and quality of their habitats (ICMBio 2010). This NAP focuses on 27 species, 26 of which are endemic to the Atlantic Forest.

Hunting is one of the major threats to mammal species in the southern Bahia region of the Atlantic Forest (Moura 2003). Consequently, one of the main goals established by the NAP is to decrease hunting pressure on target species within key

conservation areas in southern Bahia (ICMBio 2010). Three PAs were created on this biologically rich region, which are the Una Biological Reserve, the Una Wildlife Refuge and the Serra das Lontras National Park (Schroth et al. 2011). Una Biological Reserve and Una Wildlife Refuge are longer-established and law enforcement and management efforts have been conducted in both areas (IBAMA 1997; Santos and Blanes 1999), while management actions in the more recent established Serra das Lontras National Park and its buffer zone are still scarce.

Our research aims to provide information to the NAP, focusing on two of its proposed actions; investigating hunting practices, and developing a method to assess hunting pressure (ICMBio 2010). However, recording information on sensitive and illegal behaviour such as hunting inside and around protected areas is not an easy task, especially when residents are aware of the illegality of the activity. Different methods have been used to collect data on illegal use of resources around the world (Gavin et al. 2010). Novel approaches have emerged as valuable ways to obtain more accurate information about these sensitive behaviours (Nuno and St John 2015), such as the Randomized Response Technique (Solomon et al. 2007; Razafimanahaka et al. 2012; St John et al. 2012).

This study aimed to investigate motivations and prevalence of hunting by rural people in protected areas and a buffer zone of the Atlantic Forest in southern Bahia and which species are the most consumed, with a focus on threatened mammals. We also verified possible effects of socioeconomic factors on prevalence of hunting. We expected that the motivations for, and prevalence of, hunting would vary depending on the location of hunting; specifically we expected to find a higher prevalence of hunting in the newest PA and in its Buffer Zone area, where management actions are scarce, compared to inside the longer-established PAs. To test these predictions we used two

different approaches; direct interviews and indirect questioning using the Randomized Response Technique (RRT). This is the first attempt to use the RRT in Brazil to investigate sensitive behaviour related to wildlife conservation.

Materials and Methods

Study Area

The Research was conducted in the Una-Serra das Lontras protected mosaic, which contains three PAs (Una Biological Reserve, Una Wildlife Refuge and Serra das Lontras National Park) and a buffer zone (Fig. 1). The PAs cover a total area of 53,240 ha and are located in the municipalities of Una and Arataca in southern Bahia, Brazil. The main economic activities in the region are agriculture and forestry. Most people cultivate rubber, cocoa, cassava and coconut (Alger and Caldas 1994; Sollberg et al. 2014). There are approximately 970 private properties in the four areas.

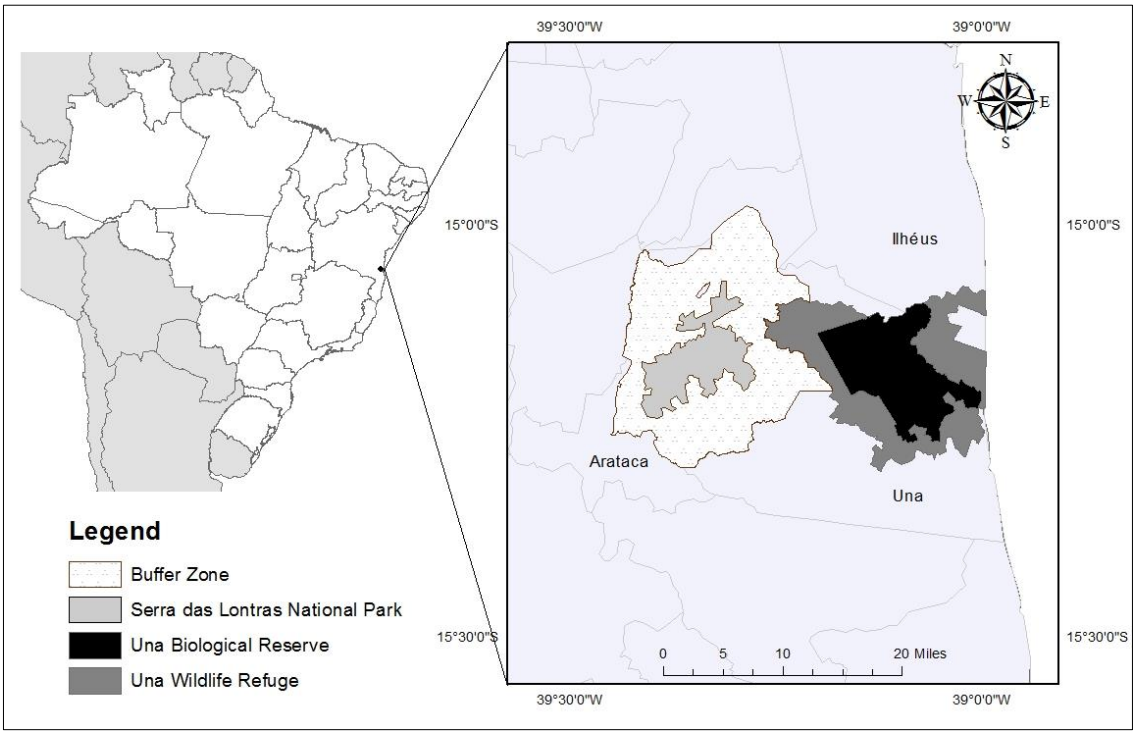

Fig. 1 Study area composed of three protected areas and a buffer zone in southern Bahia, Brazil.

Una Biological Reserve (UBR, World Conservation Union [IUCN] category Ia) comprises one of the largest remnants of Atlantic Forest in southern Bahia (Schroth et al. 2011). It was created in December 1980 comprising an area of 11,400 hectares. In 2007, along with the creation of the Una Wildlife Refuge (IUCN category III), the Reserve had its area expanded to 18,500 ha. Una Wildlife Refuge (UWR) was formerly UBR's Buffer zone. It was established in December 2007 covering an area of 23,404 ha. Serra das Lontras National Park (SLNP, IUCN category II) was established in June 2010. The park is located in the municipalities of Una, São José da Vitória and Arataca and covers an area of 11,336 hectares. The Park comprises one of the last remnants of montane Atlantic Forest in northeastern Brazil (Schroth et al. 2011). The Buffer Zone (BZ) is located around the SLNP and comprises an area of 58,796 hectares.

The National System of Conservation Units' law (Art. 10 and 11 Federal Law 9.985/2000) states that all private areas inside UBR and SLNP should be expropriated, while in UWR, private landownership is allowed within its limits, as long as land use is compatible with the conservation goals of the reserve. If this condition is not met, the private land must also be expropriated in UWR (MMA 2000). According to Chico Mendes Institute for Biodiversity Conservation (ICMBio), which manages all federal PAs, expropriation of private properties within SLNP´s boundaries has not yet been initiated. However, in the more established PA, UBR, expropriation has taken place in 51% of properties. There were no expropriations at UWR.

Target species

We focused on mammal species, especially the threatened species listed in the National Action Plan (NAP) for the Conservation of Central Atlantic Forest Mammals

occurring in southern Bahia, as well as mammals that are commonly hunted by local communities in the Atlantic Forest region (Table 1).

Table 1 Species targeted in this study and their conservation status (LC: Least concern; CR: Critically endangered; EN: Endangered; VU: Vulnerable). Also shown is whether the species was included in the RRT study.

Scientific name	Common names	IUCN Status	RRT	Reference
		Preferred species		
Cuniculus paca	Paca	LC	Yes	Pereira and Schiavetti 2010; Flesher and Laufer 2013
Dasypus novemcinctus,	Nine-banded armadillo	LC	Yes	Pereira and Schiavetti 2010; Flesher and Laufer 2013
Cabassous unicinctus	Naked-tailed armadillo		No	Pereira and Schiavetti 2010
Pecari tajacu	Collared peccary	LC	Yes	Cullen Jr. et al 2000; Flesher and Laufer 2013
Didelphis aurita	Opossum	LC	No	Pereira and Schiavetti 2010; Hanazaki et al 2009
Mazama sp.	Deer	LC	Yes	Cullen Jr. et al 2000; Flesher and Laufer 2013
		NAP-CCAFM[a] species		
Alouatta guariba guariba	Northern Brown Howler Monkey	CR	No	ICMBio 2010
Sapajus xanthosternos	Yellow-Breasted Capuchin	CR	Yes	ICMBio 2010
Phyllomys unicolor	Unicolored Tree-Rat	CR	No	ICMBio 2010
Leontopithecus chrysomelas	Golden-Headed Lion Tamarin	EN	Yes	ICMBio 2010
Callicebus melanochir	Southern Bahian Masked Titi	VU	Yes	ICMBio 2010
Bradypus torquatus	Maned Sloth	VU	Yes	ICMBio 2010
.*Chaetomys subspinosus*	Thin-spined porcupine	VU	Yes	ICMBio 2010
Callistomys pictus	Painted Tree-rat	VU	No	ICMBio 2010

[a] National Action Plan for the Conservation of Central Atlantic Forest Mammals.

Data collection

Data were collected from October 2012 to May 2014. As well as conducting interviews, we collected indirect observations about hunting during fieldwork and obtained information from other projects taking place during the same period and area of study. We also obtained patrol data from 2010 to 2013 from ICMBio. Semi-structured interviews were conducted with rural residents in the three PAs (UBR, UWR

and SLNP) and in the Buffer Zone. RRT interviews were carried out with different respondents in UWR and BZ. When possible, interviews were performed in the presence of a local field assistant, to generate higher confidence between interviewee and researcher and to improve the quality of answers. We assured confidentiality to respondents and all interviews were conducted with their consent (State University of Santa Cruz - Ethics Committee – CAAE: 03600412.0.0000.5526). Authorization to perform research inside PAs was also provided by ICMBio (SISBIO-ICMBio: 34574-1).

To randomly select our sample of interviewees, we obtained data from ICMBio containing georeferenced locations of properties inside the PAs and in part of the buffer zone. However, we also conducted additional opportunistic sampling by including extra villages located in the edge of the protected areas to increase the sample size of interviews using RRT. We could not access all properties for safety reasons. Some of the areas were located in places with very difficult access or in a conflict area disputed between indigenous people and farmers. On arrival at a property we interviewed the person responsible for it or anyone who was available, including both landowners and workers, and men and women. Only one person per property was interviewed.

Direct interviews

We approached 170 respondents, of whom 169 agreed to be interviewed. This high response rate was probably because our first approach was about non-sensitive subjects. However, we sensed that most people were not comfortable talking about hunting, since they knew that this activity is illegal. In 28 interviews, respondents denied association with hunting but provided information that suggested an association. Despite this we assumed that they were indeed non-hunters.

The interview was organized into three parts (Supplementary material 1):

Part I: Socioeconomic information on respondents including their genre, age, level of formal education, duration of residence, number of people living at home, income, government assistance ("Bolsa Família") and presence of livestock.

Part II: Respondent's perceptions regarding wildlife and hunting activities in the villages. We used photographs of the target species to verify recognition and perception of occurrence by residents.

Part III: Information about hunting: whether the respondent hunted inside protected areas, their motivations and which species were hunted. We considered two forms of hunting; opportunistic hunting (the individual captures and kills a wild animal if they encounter it near their house or during work), and active hunting (the individual hunts using firearms, traps and dogs). Consequently, to verify prevalence of hunting we used two questions: "Do you hunt (actively) in this area?" and "Do you capture a wild animal if you find it opportunistically?".

Randomized Response Technique (RRT)

The Randomized Response Technique was originally developed by Warner (1965) to eliminate evasive answers and response bias in sensitive questions, guaranteeing confidentiality for respondents' answers (Gavin et al. 2010). Studies have shown that the RRT increases the estimates of illegal behaviour compared to the results obtained by direct questioning, demonstrating it is a useful technique for assessing sensitive behaviour such as illegal resource use (Solomon et al. 2007; St. John et al. 2010; St John et al. 2012).

We used RRT to investigate mammal consumption, focused on four species known to be preferred for consumption, which can be legally hunted only in the buffer

zone and in a case of necessity to satisfy the hunger of a person, and five threatened species which are illegal to hunt anywhere (Table 1). We also included chicken as a control. Based on a pilot study, we used a paired-alternative approach, also known as the “two unrelated questions” technique; one question is related to the sensitive behaviour and the other question is related to a non-sensitive behaviour. The approach was adapted from Solomon et al. (2007). First, we asked the respondent to identify which of the nine wild animals they recognized from the photographs. Then we separated out the recognized species to be used in the interview. We showed two cards to the respondent, one with the animal picture and one with a picture of a coin, explaining the questions that each card represented, and then placed them inside the envelopes. Second, we gave a coin to the respondent to flip before selecting the envelope. The respondent randomly selected one of the envelopes and saw which card was inside. Both envelopes and cards had the same shape and size. They then only answered “yes” or “no”, without telling us which card they were looking at. If they selected the photo of an animal, they would answer "yes" if they had eaten that animal in the last 12 months or "no" otherwise. But if they selected the coin card, they would answer "yes" if they got heads when they flipped the coin, and "no" for tails. The interviewer did not know which card the respondent had chosen, ensuring anonymity. The procedure was repeated for the rest of the species. In addition, we also investigated socioeconomic information on respondents including their genre, age, level of formal education, duration of residence, number of people living at home and government assistance (“Bolsa Família”).

Of the 202 people approached for the RRT interviews (a non-overlapping sample with the direct interview survey), 20 (10%) did not wish to participate. Two of them refused because they did not understand the method, while the others refused to

participate before the method was explained, suggesting the sensitivity of the subject was the main reason for refusal. For people who found it difficult to understand the RRT, we carefully explained the method until the respondent feel confident to participate. Overall, we received 182 responses to the RRT interviews.

Data analysis

We used both the responses to direct questioning and RRT results to estimate the prevalence of hunting and consumption. We use a Generalized Linear Model (logistic ancova) to verify whether hunting in a location (binary response) is affected by continuous (age, duration of residence and number of people at home) and categorical (education, government assistance, livestock and location) explanatory variables. We did not use income as an explanatory variable because we could not identify reliable values. We used Anova for model simplification to find the minimal adequate model which also had the lowest AIC (Akaike information criterion) value. Correlation coefficients between the explanatory variables were also tested to verify association among the measured variables. There was no strong correlation between variables.

Pearson X^2 (contingency tables) tests were also performed to explore association between respondents' perceptions and locations, while simple logistic regression was used to verify relationship between age and respondents' perception about wildlife abundance. To estimate the proportion of people consuming the species investigated by RRT, we used the following equation (Fox and Tracy 1986):

$$X = \frac{\lambda - (1-p)\pi}{p}$$

and to calculate the estimated variance for the population surveyed, we used:

$$Var(X) = \frac{\lambda(1-\lambda)}{np^2}$$

where X = estimated proportion of respondents consuming the species, λ = recorded proportion of 'yes' responses, π = known proportion of non-sensitive behaviour (=0.5, i.e. flipping heads in the coin toss), p=probability of selecting the sensitive question (=0.5) and n=number of respondents. We performed regression models using a customized link function (Keane 2014) to explore associations between the estimates of consumption obtained from RRT and socioeconomic variables.

We had lower numbers of interviews in two of the areas (UBR and SLNP). People living inside the SLNP were usually located in areas at higher altitude where access was difficult. In UBR, there were few people living inside the area whose properties had not yet been expropriated. We therefore grouped UBR with UWR and SLNP with BZ, based on the proximity of the areas and the history of the creation of the PAs. UWR used to be the UBR's buffer zone. Both areas are relatively long established and management activities usually occur in both areas (IBAMA 1997). In addition, the expanded area of UBR, where most of UBR residents live, was created at the same time as UWR, while SLNP and its buffer zone were created more recently.

Results

A total of 351 interviews were performed within the three protected areas and the buffer zone (Table 2).

Table 2 Socioeconomic characteristics of rural residents in protected areas of Southern Bahia responding to the direct interviews and Randomized Response Technique (RRT).

	Direct Interviews				RRT interviews	
	UWR[a] n=74	UBR[b] n=20	SLNP[c] n=11	BZ[d] n=64	UWR[a] n=81	BZ[d] n=101
Genre						
Men	57	15	11	45	52	54
Age (years)	50.5(16-84)[e]	50.5(26-82)	56(50-72)	48(20-81)	45(18-90)	45(18-89)
Duration of residence (years)	20(0.33-62)	7(1.5-28)	26(1-59)	15(0.1-61)	20(0.1-58)	11(0.1-65)
Nº of people living at home	3(0-10)	3(1-21)	2(1-6)	3.5(1-12)	3(1-17)	3 (1-7)
Level of formal Education						
Illiterate	47%	60%	27%	27%	22%	20%
Primary-School	27%	25%	55%	40%	35%	40%
Middle-school	12%	10%	9%	16%	20%	22%
High-School-College	14%	5%	9%	16%	23%	18%
Government assistance						
Yes	57%	45%	18%	44%	31%	36%
Livestock						
Yes	58%	70%	90%	77%	-	-

[a] Una Wildlife Refuge
[b] Una Biological Reserve
[c] Serra das Lontras National Park
[d] Buffer Zone
[e] Median value (minimum-maximum)

Perceptions towards wildlife abundance and links to hunting

Respondents stated that armadillo, collared peccary and paca were the most common animals in the study area. Occurrence of these species was confirmed by 100%, 90% and 86% of respondents respectively. The northern brown howler monkey and the painted tree-rat were the least frequently recognized species, and its occurrence was only confirmed by 9% and 15% of respondents respectively (Supplementary material 2). It was not possible to obtain information on the unicolour tree rat because residents were unable to identify the species reliably.

Fifty-four percent of residents said that wildlife abundance is increasing compared to 10 years ago while 46% said that it is decreasing. This was unrelated to

respondent age or location. Several species were stated by respondents to have disappeared or decreased, and most respondents (70%) cited overhunting as the main reason. Of the species that had increased, the reasons given were that the species reproduce quickly or that hunting of the species has decreased (e.g. golden-headed lion tamarin). Respondents also reported that paca and armadillo are the most hunted species in the region (Table 3). Fifty-six percent of respondents perceived a reduction in hunting activities in their villages and surrounding areas in recent years and 44% said that hunting has not changed in prevalence. More respondents in UBR-UWR perceived a decrease in hunting compared to respondents in SLNP-BZ (X^2= 4.26, df=1, p= 0.038).

Table 3 Species cited by respondents to have increased or decreased. In addition, species cited to be the most hunted in region. Threatened species are in bold. *Species especially cited to have disappeared.

Species	Citations of species increasing (n= 51)	Citations of species decreasing (n=97)	Citations of species most hunted (n=116)
Armadillo	23		67
Collared peccary	20	7	35
Golden-headed lion tamarin	11		
Marmoset (*Callithrix* sp.)	7		
Paca	6	6	99
Capybara (Hydrochoerus Hydrochaeris)	6	4	3
Crab-eating fox (*Cerdocyon thous)*	4		
Coati (*Nasua nasua*)	3		4
Southern Bahian Masked Titi	2		
Opossum		34	3
Deer	1	18	5
Agouti (*Dasyprocta sp.*)		10	1
Maned sloth		10	
Collared anteater (*Tamandua tetradactyla*)	1	7	3
Puma (*Puma concolor*)	1	3	
Kinkajou (*Potos flavus*)	1	2	
Yellow-Breasted Capuchin		2	
Lowland tapir (*Tapirus terrestres*)*		10	
Northern brown howler monkey*		5	
White-lipped Peccary (*Tayassu pecari*)*		4	
Northern muriqui (*Brachyteles hypoxanthus*)*		3	
Giant armadillo (*Priodontes maximus*)*		3	

Prevalence of hunting and motivations

Thirty seven percent of respondents said that they hunt opportunistically, 16% hunt actively and 47% said they do not hunt. The greatest level of overall hunting was in the SLNP (82% say they hunt actively or opportunistically) and of active hunting was in BZ (22% say they are active hunters), while fewest people say they hunt in UWR (Table 4). Active hunters use hunting dogs (50%), traps (46%) and hunting platforms (12%) as strategies.

Table 4 Number of respondents stating that they hunt in protected areas of the northeast Atlantic Forest, and the number of those who hunt either opportunistically or actively (answer to the questions "Do you hunt (actively) in this area?" and "Do you capture a wild animal if you find it opportunistically?").

	UWR[a] (n=74)	UBR[b] (n=20)	SLNP[c] (n=11)	BZ[d] (n=64)	TOTAL (n=169)
Yes	31	12	9	37	89
Opportunistic hunting	25	8	7	23	63
Active hunting	6	4	2	14	26
No	43	8	2	27	80

[a] Una Wildlife Refuge.
[b] Una Biological Reserve.
[c] Serra das Lontras National Park.
[d] Buffer Zone.

The primary stated motivation for hunting was consumption (92% of responses). However wild meat was an occasional complement to diets, rather than being consumed regularly. Many respondents stated that wild meat was essential for subsistence in the past, but not anymore. Hunters said they killed for necessity, to satisfy their hunger, or because they enjoyed a particular animal's meat. Most opportunistic hunters stated that they did not consider themselves as hunters. Besides hunting for consumption, 19% of respondents who had hunted had used wild animals for medicinal purposes, 18% hunted

due to damage to crops or livestock (retaliation) and 6% said that hunting was a recreational activity (19% among active hunters). We could not identify anyone involved in hunting for commercial purposes. However, some residents provided information about wild meat prices, suggesting the existence of an illegal local trade (Supplementary material 3). Some respondents said that they knew people who relied on hunting as their major source of income and that wild meat is sold in some restaurants and markets in nearby cities. One respondent said that a friend kills less preferred wild animals including threatened species and sells the meat. In addition, hunting dogs are highly valued, costing up to US$1600 each.

Effects of socioeconomic factors on prevalence of hunting

We achieved a significant GLM for prevalence of hunting, considering socioeconomic factors. Of the initial set of seven explanatory variables, the minimal adequate model included only one variable (Supplementary material 4). Whether someone admitted to hunting was associated with their level of formal education (Table 5); respondents with primary education stated that they hunted more than people with higher or no education.

Table 5 Minimal adequate model (Logistic Ancova) showing effects of level of formal education on hunting.

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.6109	0.2850	2.144	0.0320 *
Education (Middle-school)	-0.7062	0.5216	-1.354	0.1758
Education (Highschool/College)	-1.3041	0.5436	-2.399	0.0164 *
Education (none)	-0.7651	0.3783	-2.022	0.0431 *

Hunting was not significantly related to age, duration of residence, number of people living at home, government assistance or livestock. With respect to location, we

found a slightly higher prevalence of hunting in SLNP-BZ compared to UBR-UWR, but the difference was not statistically significant.

Wild meat consumption

Using RRT, the estimate of chicken consumption over the last 12 months was not significantly different from 100%. The estimates of consumption prevalence were non-zero for armadillos (62%±14%), pacas (48%±14%), and peccaries (26%±14%). For the other species, including all the threatened species, the confidence intervals for consumption overlapped zero (Fig. 2). Wide confidence intervals are a common issue with RRT, due to the probabilistic nature of the method, requiring a large sample size. However, the confidence intervals give an upper bound on likely prevalence of consumption for these less-consumed species.

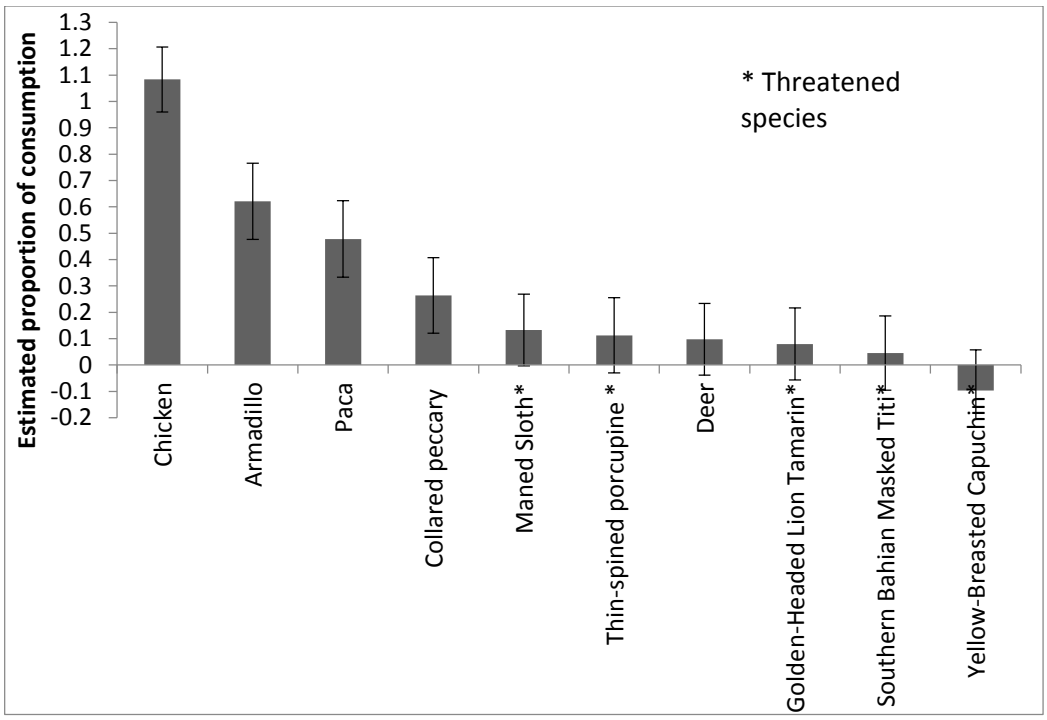

Fig. 2 Estimates of species consumption (integers= standard error) in the last 12 months inside and around protected areas of Southern Bahia.

With respect to socioeconomic factors affecting the estimated proportion of consumption obtained by the RRT, we achieved valid GLMs only for three species (paca, armadillo and collared-peccary). The candidate models are presented with AIC values and the minimal adequate models are indicated with the lowest AIC value (Supplementary material 5). The estimated consumption of pacas was higher in SLNP-BZ than in UBR-UWR, but the consumption estimates were not significantly different. Armadillo consumption tended to be higher for people with shorter duration of residence, while peccary consumption tended to be higher for older people (Table 6).

Table 6 Minimal adequate models (Logistic Ancova) showing factors affecting the estimated proportion of consumption of paca, armadillo and collared peccary, using the RRT results.

	Estimate	Std. Error	z value	Pr(>|z|)
Model 1 - Paca				
(Intercept)	-0.7029	0.5071	-1.386	0.166
PA (SLNP-BZ)	1.0784	0.6577	1.640	0.101
Model 2 - Armadillo				
(Intercept)	1.31438	0.61048	2.153	0.0313 *
Duration of residence	-0.04416	0.02392	-1.846	0.0648 .
Model 3 –Peccary				
(Intercept)	-5.71122	2.72158	-2.098	0.0359 *
Age	0.08800	0.04547	1.935	0.0530 .

Within the direct interviews, respondents cited several species as preferred for consumption. Also, a wide variety of species was cited as consumed, however few respondents reported consumption in the last 12 months (Table 7).

Table 7 Respondents' preferred wild meat (n=74) and consumption of particular species in the last 12 months (n=16). Threatened species are in bold.

Species	Preferred	Consumed
Armadillo	44	9
Paca	42	2
Opossum	28	
Collared peccary	8	1
Deer	6	
Coati	4	
Agouti (*Dasyprocta sp.*)	1	
Collared anteater	1	
Southern Bahian Masked Titi	1	
Kinkajou	1	
Maned sloth		1
Crab-eating raccoon (*Procyon cancrivorus*)		1
Capybara		1
Tayra (*Eira Barbara*)		1

Few people said that they consumed threatened species. Some species were not eaten due to taboos or cultural norms. For example, 96% of the 45 respondents who answered the question about whether they ate monkeys said that they did not and 87% of the 55 people who answered the question said they did not eat sloths. However, respondents said that some people in the area did consume some species of monkeys (76% said some people ate the Southern Bahian masked titi and 45% said people ate the Golden-headed lion tamarin) and 84% said that people sometimes consume sloths. Some residents did not consume sloths and monkeys because they look like humans. Others said that they do not consume sloths because “they are like women”, which means that the animal has the same menstrual cycle as women, or because “this animal cannot defend itself”. People also said that they did not consume porcupines because the meat is considered “remosa”, which means that it is not good for consumption by sick people or pregnant women. Consumption of these less desirable species was often said to be related to opportunistic situations, because of a need for protein and their ease of

capture. Some respondents said that hunting these species was more common in the past when subsistence hunting was more frequent.

Independent evidence for hunting activities

Our findings from the interviews that hunting does take place in PAs within the study area was supported by researchers from another project (SISBIOTA Project) meeting hunters and finding traps and hunting platforms in UBR. We also found evidence of hunting during our fieldwork in all areas, but more frequently in the Buffer Zone. Between 2010 and 2013, ICMBio registered 19 seizures related to hunting in UBR and UWR in 22 patrol days. Patrols in the region are not regular or frequent. Seventeen records (11 in UBR and six in UWR) were related to seizure of hunting equipment. Four records were related to seizure of body parts of collared anteater and armadillos. One of the men fined in UBR declared that he had hunted the critically endangered yellow-breasted capuchin. There were no law enforcement events in SLNP and BZ, due to lack of financial and human resources.

Discussion

Hunting in Protected Areas

Although subsistence hunting by indigenous and traditional communities has been widely studied in Brazil (Hanazaki et al. 2009; Pereira and Schiavetti 2010; Barbosa et al. 2011), especially in the Amazon region (Peres 1990; Peres 2001; Peres and Nascimento 2006; Minzenberg and Wallace 2011), illegal hunting in PAs has been poorly investigated. Because of the complete prohibition of the activity in the country, people are aware that hunting is illegal and this makes research on this subject difficult (Alves and Souto 2011). Our results show that hunting of mammals, including endemic

and threatened species, occurs in and around PAs in the southern Bahia region of Atlantic Forest. Most hunting occurred occasionally, and predominately to complement the diet of the rural residents, though also for medicinal, recreation and retaliation reasons. Consumption of wild meat is common around the country for subsistence (Peres 2000; Peres and Nascimento 2006; Hanazaki et al. 2009; Barbosa et al. 2011; Minzenberg and Wallace 2011) and because rural residents appreciate its flavour (Fernandes-Ferreira et al. 2012). We also obtained some indirect evidence of commercial hunting for the illegal wild meat trade. In Brazil, commercial hunting is forbidden by law, but nevertheless illegal commercialization of threatened species such as the yellow-breasted capuchin has been documented in Bahia State (Nascimento et al. 2013).

Respondents were split on whether hunting had increased or decreased and whether species abundance had changed. This is interesting because we expected that respondents would perceive a decrease in hunting and possibly an increase in species abundance in all study region, even if to different degrees, because of the establishment of three PAs. In general, the perception of a decrease in hunting was higher in UBR-UWR, but changes in species abundance are not clearly evident. In addition, a range of different evidence suggested hunting prevalence was slightly higher in SLNP-BZ than UBR-UWR, although it took place throughout the study area. The absence of law enforcement in SLNP-BZ and its more recent establishment as a PA could be contributing to this higher hunting prevalence. Since UBR's creation in 1980, educational activities and technical support for agriculture have been carried out for rural residents living adjacent to the PA, which is nowadays designated as the UWR (IBAMA 1997). This may have reduced hunting (Santos and Blanes 1997; Santos and Blanes 1999). We also found a relationship between educational level and hunting, with

people with primary education hunting more than illiterate people (who were generally older) or those with higher levels of education. A similar relationship between lower level of education and dependence on natural resources, including hunting, has been found elsewhere (e.g. Gunatilake 1998; Nielsen and Meilby 2013). Therefore, actions that support and incentive school attendance by local residents of the PAs and the BZ, especially efforts that guarantee infrastructure and access to middle and high-school, besides the primary education, may help to improve local people's support on wildlife conservation and consequently reduce illegal hunting.

Consumption of species

Our results, that paca, armadillo and collared peccary were both the most consumed species and the most preferred wild meats, confirm the findings of other studies in the region and nationally (Cullen Jr et al. 2000; Pereira and Schiavetti 2010; Flesher and Laufer 2013). Although the consumption of threatened species was low in the study area (too low for the RRT to be able to estimate prevalence robustly), our evidence obtained by direct interviews suggests that it does go on. This is of concern as even a low rate of hunting may affect populations of protected species (Noss 2000). Some species, particularly monkeys, sloths and porcupines, are not appreciated for consumption. Taboos can sometimes reduce hunting pressure on threatened and endemic species (Colding and Folke 1997; Jones et al. 2008), but are not always enough; our respondents suggested that when there is need for animal protein and opportunity for a easy hunt, species usually protected by taboos are still hunted (see also Castilho et al. 2013).

Although the most preferred, and most consumed, species are relatively common in the study region, hunting can still lead to declines (e.g. of the opossum; Cassano and

Kierulff 2009). Cassano et al. (2012) did not find paca, peccary or deer in cameras-trap in the study region, suggesting that hunting may have caused these species to become uncommon. Species that should occur in the region were either cited as disappeared or were not known to the respondents, suggesting that there may have been hunting-related extirpations in the past. These include, among others, the northern brown howler monkey, which is probably locally extinct (Flesher and Laufer 2013; Neves et al. 2014).

Methods to investigate illegal hunting

We found that using a range of techniques was a valuable strategy to collect information about illegal hunting and to triangulate our results. Our respondents were sometimes uncomfortable with the subject-matter, but despite that, direct interviews allowed us to obtain detailed information about hunting and explore respondents' perceptions and knowledge. However, direct interviews are prone to non-responses and false answers (Gavin et al. 2010; Bitanyi et al. 2012; Mgawe et al. 2012). It may be that the proportion of people involved in hunting is underestimated in our study, especially those undertaking active hunting. RRT was also a valuable approach, as it guaranteed confidentiality to our respondents and allowed us to investigate information about species consumption. However the method has drawbacks, including the complex explanations required, especially if the targeted population is illiterate (St. John et al. 2010; Razafimanahaka et al. 2012). People can still be suspicious of the technique, particularly if the questions are very sensitive. In addition, a large sample size is necessary in order to produce precise estimates (Lensvelt-Mulders et al. 2005). Our study suffered from a relatively small sample size, resulting in large standard errors, which affected our ability to estimate consumption of the less widely consumed species.

Other specialized questioning techniques, such as the Unmatched-count Technique (UCT), could also be tested (Nuno et al. 2013).

Management implications

Reducing hunting pressure on threatened species is one of the goals of the National Action Plan in southern Bahia (ICMBio 2010). The relatively low level of consumption of threatened species and existing taboos suggest that achieving this goal is not an impossible task. However to reach this goal is necessary to engage with communities living inside and around the PAs. This could include, in the short-term, an expanded education program to provide information about the conservation status and rules around hunting these species (Milner-Gulland and Bennett 2003; Cassano et al. 2009; Gandiwa 2011; Melo et al. 2014), and in the long-term, development efforts that guarantee school (primary, middle and high school) access to residents living in and around the PAs. It is also necessary to explore people's feelings about expropriation of property and about the legal restrictions on consumptive use, in order to understand their perspectives and build consensus about the best way to manage the area in order to benefit both local people and conservation.

Our study suggests that people who hunt non-preferred species, including threatened ones, may do it for lack of animal protein. This suggests that investing in diversifying livelihood activities and protein sources may be a useful approach (Loibooki et al. 2002; Bitanyi et al. 2012). However, it is important not only focus in the threatened species. When preferred medium-large bodied mammals decrease, hunters may start to target smaller and non-preferred species (Bennett et al. 2002; Jerozolimski and Peres 2003; Rowcliffe et al. 2003). Also, medium-large bodied

mammals are important for maintaining ecosystem functions, through activities such as seed predation and seed dispersal (Stoner et al. 2007; Wright et al. 2007).

The presence of long-term research teams can provide additional protection to wildlife, particularly where law enforcement is weak (Campbell et al. 2011; Tagg et al. 2015). Long-term monitoring projects inside our study area could therefore reduce illegal activities, particularly if researchers employ local people and take time to engage with local people and their concerns. Finally, anti-poaching patrols are essential to decrease poaching within conservation areas (Hilborn et al. 2006). Considering the scarcity of patrols in the three studied PAs, law enforcement needs to be improved in concert with initiatives to improve local livelihoods, particularly to reduce the illegal local trade of wild meat and reduce illegal hunting in areas where active hunting was higher.

Conclusion

Reducing hunting in PAs is challenging and complex and requires an integrated approach. It is clear from our study that there is widespread illegal hunting within PAs, but that people mostly want to hunt common species for their own consumption. In these circumstances, it is necessary to take an approach to wildlife management that involves local people, so that wildlife is conserved and the welfare of rural residents is enhanced. This may involve thinking more broadly about the legal restrictions on hunting within protected areas, not just implementing and enforcing existing laws.

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References

Alger K, Caldas M (1994) The declining cocoa economy and the Atlantic forest of southern Bahia, Brazil: conservation attitudes of cocoa planters. Environmentalist 14:107–119.

Alves RR, Souto WM (2011) Ethnozoology in Brazil: current status and perspectives. J Ethnobiol Ethnomed. doi: 10.1186/1746-4269-7-22

Alves RRN (2009) Fauna used in popular medicine in Northeast Brazil. J Ethnobiol Ethnomed. doi: 10.1186/1746-4269-5-1

Alves RRN, Mendonça LET, Confessor MVA, et al (2009) Hunting strategies used in the semi-arid region of northeastern Brazil. J Ethnobiol Ethnomed. doi: 10.1186/1746-4269-5-12

Barbosa JAA, Nobrega VA, Alves RRN (2011) Hunting practices in the semiarid region of Brazil. Indian J Tradit Knowl 10:486–490.

Bennett E, Eves H, Robinson J, Wilkie D (2002) Why is eating bushmeat a biodiversity crisis? Conserv Biol Pract 3:2–3.

Bennett EL, Robinson J (2000) Hunting for the Snark. In: Robinson JG, Bennett EL (eds) Hunting for sustainability in tropical forests. Columbia University Press, New York, pp 1–9

Bitanyi S, Nesje M, Kusiluka LJM, et al (2012) Awareness and perceptions of local people about wildlife hunting in western Serengeti communities. Trop Conserv Sci 5:208–224.

Campbell G, Kuehl H, Diarrassouba A, et al (2011) Long-term research sites as refugia for threatened and over-harvested species. Biol Lett 7:723–726. doi: 10.1098/rsbl.2011.0155

Canale GR, Peres CA, Guidorizzi CE, et al (2012) Pervasive defaunation of forest remnants in a tropical biodiversity hotspot. PLoS One 7:e41671. doi: 10.1371/journal.pone.0041671

Carvalho Jr EAR, Morato RG (2013) Factors affecting big cat hunting in Brazilian protected areas. Trop Conserv Sci 6:303–310.

Carvalho EAR, Pezzuti JCB (2010) Hunting of jaguars and pumas in the Tapajós–Arapiuns Extractive Reserve, Brazilian Amazonia. Oryx 44:610–612. doi: 10.1017/S003060531000075X

Cassano C, Kierulff M (2009) Diversidade de mamíferos não voadores no Complexo de Serras das Lontras. In: SAVE Brasil, IESB e BirdLife International. Complexo de Serras das Lontras e Una, Bahia: Elementos naturais e aspectos de sua conservação. São Paulo: SAVE Brasil.

Cassano CR, Barlow J, Pardini R (2012) Large Mammals in an Agroforestry Mosaic in the Brazilian Atlantic Forest. Biotropica 44:818–825. doi: 10.1111/j.1744-7429.2012.00870.x

Cassano CR, Schroth G, Faria D, et al (2009) Landscape and farm scale management to enhance biodiversity conservation in the cocoa producing region of southern Bahia, Brazil. Biodivers Conserv 18:577–603. doi: 10.1007/s10531-008-9526-x

Castilho LC, Martinez RA, Ribeiro GC, Schiavetti A (2013) The thin-spined porcupine, Chaetomys subspinosus (Rodentia: Erethizontidae), within protected areas in the

Atlantic Forest, Brazil: local knowledge and threats. Trop Conserv Sci 6:796–810.

Chiarello AG (2000) Influência da caça ilegal sobre mamíferos e aves das matas de tabuleiro do norte do estado do Espírito Santo. Bol do Mus Biol Mello Leitão (Nova Série) 11/12:229–247. doi: 10.1590/S1676-06032009000300038

Colding J, Folke C (1997) The relations among threatened species, their protection, and taboos. Conservation Ecology 1:1.

Corlett RT (2007) The impact of hunting on the mammalian fauna of tropical Asian forests. Biotropica 39:292–303. doi: 10.1111/j.1744-7429.2007.00271.x

Cullen Jr L, Bodmer ER, Valladares-Padua C (2001) Ecological consequences of hunting in Atlantic forest patches, Ä o Paulo, Brazil Sa. Oryx 35:137–144. doi: 10.1046/j.1365-3008.2001.00163.x

Cullen Jr L, Bodmer RE, Valladares Pádua C (2000) Effects of hunting in habitat fragments of the Atlantic forests, Brazil. Biol Conserv 95:49–56. doi: 10.1016/S0006-3207(00)00011-2

El Bizri HR, Morcatty TQ, Lima JJS, Valsecchi J (2015) The thrill of the chase: uncovering illegal sport hunting in Brazil through YouTube posts. Ecol Soc. doi: 10.5751/ES-07882-200330

Fa JE, Brown D (2009) Impacts of hunting on mammals in African tropical moist forests: A review and synthesis. Mamm Rev 39:231–264. doi: 10.1111/j.1365-2907.2009.00149.x

Fa JE, Peres CA, Meeuwig J (2002) Bushmeat Exploitation in Tropical Forests: an Intercontinental Comparison. Conserv Biol 16:232–237. doi: 10.1046/j.1523-1739.2002.00275.x

Fernandes-Ferreira H, Mendonça SV, Albano C, et al (2012) Hunting, use and conservation of birds in Northeast Brazil. Biodivers Conserv 21:221–244. doi: 10.1007/s10531-011-0179-9

Fernandes-Ferreira H, Mendonça SV, Cruz RL, et al (2013) Hunting of herpetofauna in montane, coastal and dryland areas of Northeastern Brazil. Herpetol Conserv Biol 8:652–666.

Flesher KM, Laufer J (2013) Protecting wildlife in a heavily hunted biodiversity hotspot: a case study from the Atlantic Forest of Bahia, Brazil. Trop Conserv Sci 6:181–200.

Foerster S, Wilkie DS, Morelli GA, et al (2012) Correlates of Bushmeat Hunting among Remote Rural Households in Gabon, Central Africa. Conserv Biol 26:335–344. doi: 10.1111/j.1523-1739.2011.01802.x

Fox JA, Tracy PE (1986) Randomized response: A method for sensitive surveys. Sage Publications, Beverly Hills, CA

Gandiwa E (2011) Preliminary assessment of illegal hunting by communities adjacent to the northern Gonarezhou National Park, Zimbabwe. Trop Conserv Sci 4:445–467.

Gavin MC, Solomon JN, Blank SG (2010) Measuring and Monitoring Illegal Use of Natural Resources. Conserv Biol 24:89–100. doi: 10.1111/j.1523-1739.2009.01387.x

Gunatilake HM (1998) The role of rural development in protecting tropical rainforests: evidence from Sri Lanka. J Environ Manage 53:273–292.

Hanazaki N, Alves R, Begossi A (2009) Hunting and use of terrestrial fauna used by Caiçaras from the Atlantic Forest coast (Brazil). J Ethnobiol Ethnomed. doi: 10.1186/1746-4269-5-36

Hilborn R, Arcese P, Borner M, et al (2006) Effective enforcement in a conservation area. Science 314:1266. doi: 10.1126/science.1132780

IBAMA (1997) Plano de Manejo da Reserva Biológica de Una. http://www.icmbio.gov.br/portal/images/stories/imgs-unidades-coservacao/REBIOUna.pdf. Accessed 10 Feb 2015

ICMBio (2014) Planos de Ação Nacional. http://www.icmbio.gov.br/portal/biodiversidade/fauna-brasileira/planos-de-acao-nacional.html. Accessed 1 Mar 2015

ICMBio (2010) Executive Summary of the National Action Plan for the Conservation of Central Atlantic Forest Mammals.

http://www.icmbio.gov.br/portal/images/stories/docs-plano-de-acao/pan-mamiferos-da-mata-atlantica/sumario_mamiferos_mata_atlantica_ingles.pdf. Accessed 1 Mar 2012

Jerozolimski A, Peres CA (2003) Bringing home the biggest bacon: A cross-site analysis of the structure of hunter-kill profiles in Neotropical forests. Biol Conserv 111:415–425. doi: 10.1016/S0006-3207(02)00310-5

Jones JPG, Andriamarovololona MM, Hockley N (2008) The importance of taboos and social norms to conservation in Madagascar. Conserv Biol 22:976–986. doi: 10.1111/j.1523-1739.2008.00970.x

Keane A (2014) Sensitive: Functions for the analysis of sensitive survey data collected using specialised questioning techniques. R package version 0.1.

Lensvelt-Mulders G, Hox J, Van Der Heijden P (2005) How to improve the efficiency of randomised response designs. Qual Quant 39:253–265. doi: 10.1007/s11135-004-0432-3

Levi T, Shepard Jr GH, Ohl-Schacherer J, et al (2011) Spatial tools for modeling the sustainability of subsistence hunting in tropical forests. Ecol Appl 21:1802–1818. doi: 10.1890/10-0375.1

Loibooki M, Hofer H, Campbell KLI, East ML (2002) Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. Environ Conserv 29:391–398. doi: 10.1017/S0376892902000279

Melo RS, Silva OC, Souto A, et al (2014) The role of mammals in local communities living in conservation areas in the Northeast of Brazil: an ethnozoological approach. Trop Conserv Sci 7:423–439.

Mgawe P, Mulder MB, Caro T, et al (2012) Factors affecting bushmeat consumption in the Katavi-Rukwa ecosystem of Tanzania. Trop Conserv Sci 5:446–462.

Milner-Gulland EJ, Bennett EL (2003) Wild meat: the bigger picture. Trends Ecol Evol 18:351–357. doi: 10.1016/S0169-5347(03)00123-X

Minzenberg E, Wallace R (2011) Amazonian agriculturalists bound by subsistence

hunting. J Cult Geogr 28:99–121. doi: 10.1080/08873631.2011.548482

MMA (2000) Sistema Nacional de Unidades de Conservação (SNUC). http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=322. Accessed 12 Nov 2015

Morcatty T, Valsecchi J (2015) Social, biological, and environmental drivers of the hunting and trade of the endangered yellow-footed tortoise in the Amazon. Ecology and Society 20(3): 3. doi:10.5751/ES-07701-200303

Moura RT De (2003) Distribuiçao e ocorrência de mamíferos na Mata Atlântica do sul da Bahia. In: Prado PI, Landau EC, Moura RT, et al. (eds) Corredor de Biodiversidade da Mata Atlântica do Sul da Bahia. CD-ROM, Ilhéus, IESB / CI / CABS / UFMG / UNICAMP, pp 1–22

Myers N, Mittermeier RA, Mittermeier CG, et al (2000) Biodiversity hotspots for conservation priorities. Nature 403:853–858. doi: 10.1038/35002501

Nascimento RA, Schiavetti A, Montaño RAM (2013) An assessment of illegal capuchin monkey trade in Bahia State, Brazil. Neotrop Biol Conserv 8:79–87. doi: 10.4013/nbc.2013.82.03

Nasi R, Taber a., Van Vliet N (2011) Empty forests, empty stomachs? Bushmeat and livelihoods in the Congo and Amazon Basins. Int For Rev 13:355–368. doi: 10.1505/146554811798293872

Neves LG, Clark FE, Melo FR, et al (2014) Northern Brown Howler Monkey. In: Schwitzer C, Mittermeier RA, Rylands AB, et al. (eds) Primates in Peril: The World's 25 Most Endangered Primates 2012–2014. IUCN SSC Primate Specialist Group (PSG), International Primatological Society (IPS), Conservation International (CI), and Bristol Zoological Society, Arlington, VA.

Nielsen MR, Meilby H (2013) Determinants of compliance with hunting regulations under Joint Forest Management in Tanzania. South African J Wildl Res 43:120–137. doi: 10.3957/056.043.0210

Noss A (2000) Cable snare and nets in the Central African Republic. In: Robinson JG, Bennett EL (eds) Hunting for sustainability in tropical forests. Columbia

University Press, New York

Nuno A, Bunnefeld N, Naiman LC, Milner-Gulland EJ (2013) A Novel Approach to Assessing the Prevalence and Drivers of Illegal Bushmeat Hunting in the Serengeti. Conserv Biol 27:1355–1365. doi: 10.1111/cobi.12124

Nuno A, St John FA V (2015) How to ask sensitive questions in conservation: A review of specialised questioning techniques. Biol Conserv 189:5–15. doi: 10.1016/j.biocon.2014.09.047

Pereira J, Schiavetti A (2010) Conhecimentos e usos da fauna cinegética pelos caçadores indígenas “Tupinambá de Olivença” (Bahia). Biota Neotropica 10(1): 175-183.

Peres CA (1990) Effects of hunting on western Amazonian primate communities. Biol Conserv 54:47–59.

Peres CA (2001) Synergistic effects of subsistence hunting and habitat fragmentation on Amazonian forest vertebrates. Conserv Biol 15:1490–1505.

Peres CA (2000) Effects of Subsistence Hunting on Vertebrate Community Structure in Amazonian Forests. Conserv Biol 14:240–253.

Peres CA, Emilio T, Schietti J, et al (2016) Dispersal limitation induces long-term biomass collapse in overhunted Amazonian forests. PNAS 113:892–897. doi: 10.1073/pnas.1516525113

Peres CA, Nascimento HS (2006) Impact of game hunting by the Kayapó of south-eastern Amazonia: Implications for wildlife conservation in tropical forest indigenous reserves. Biodivers Conserv 15:2627–2653. doi: 10.1007/s10531-005-5406-9

Peres CA, Palacios E (2007) Basin-wide effects of game harvest on vertebrate population densities in Amazonian forests: implications for animal-mediated seed dispersal. Biotropica 39:304–315. doi: 10.1111/j.1744-7429.2007.00272.x

Razafimanahaka J, Jenkins R, Andriafidison D, et al (2012) Novel approach for quantifying illegal bushmeat consumption reveals high consumption of protected species in Madagascar. Oryx 46:584–592. doi: 10.1017/S0030605312000579

Redford KH (1992) The empty forest. Bioscience 42:412–422.

Ribeiro GC, Pereira JPR, Docio L, et al (2010) Zooteráticos utilizados no sul da Bahia. In: Costa Neto EM, Alves RRN (eds) Zooterapia: os animais na medicina popular brasileira. NUPPEA, Recife, PE

Rowcliffe JM, Cowlishaw G, Long J (2003) A model of human hunting impacts in multi-prey communities. J Appl Ecol 40:872–889.

Santos G, Blanes J (1999) Environmental education as a strategy for conservation of the remnants of Atlantic forest surrounding Una Biological Reserva, Brazil. Dodo 35:151–157.

Santos G, Blanes J (1997) Environmental education programme with the community surrounding Una Biological Reserve, Bahia, Brazil. Dodo 33:118–126.

Schiavetti A, Magro TC, Santos MS (2012) Implementação das Unidades de Conservação do Corredor Central da Mata Atlântica no estado da Bahia: desafios e limites. Rev Árvore 36:611–623. doi: 10.1590/S0100-67622012000400004

Schroth G, Faria D, Araujo M, et al (2011) Conservation in tropical landscape mosaics: the case of the cacao landscape of southern Bahia, Brazil. Biodivers Conserv 20:1635–1654. doi: 10.1007/s10531-011-0052-x

Sollberg I, Schiavetti A, Moraes M (2014) Manejo agrícola no Refúgio de Vida Silvestre de Una: Agroflorestas como uma perspectiva de conservaçao. Árvore 38:241–250.

Solomon J, Jacobson SK, Wald KD, Gavin M (2007) Estimating Illegal Resource Use at a Ugandan Park with the Randomized Response Technique. Hum Dimens Wildl 12:75–88. doi: 10.1080/10871200701195365

St John FA V., Keane AM, Edwards-Jones G, et al (2012) Identifying indicators of illegal behaviour: carnivore killing in human-managed landscapes. Proc R Soc B 279:804–812. doi: 10.1098/rspb.2011.1228

St. John FA V, Edwards-Jones G, Gibbons JM, Jones JPG (2010) Testing novel methods for assessing rule breaking in conservation. Biol Conserv 143:1025–1030. doi: 10.1016/j.biocon.2010.01.018

Stoner KE, Riba-Hernández P, Vulinec K, Lambert JE (2007) The Role of Mammals in Creating and Modifying Seedshadows in Tropical Forests and Some Possible Consequences of Their Elimination. Biotropica 39:316–327.

Tabarelli M, Pinto L, Silva J, et al (2005) Challenges and Opportunities for Biodiversity Conservation in the Brazilian Atlantic Forest. Conserv Biol 19:695–700.

Tagg N, Willie J, Duarte J, et al (2015) Conservation research presence protects: a case study of great ape abundance in the Dja region, Cameroon. Anim Conserv. doi: 10.1111/acv.12212

Van Vliet N (2011) Livelihood alternatives for the unsustainable use of bushmeat. Report prepared for the CBD Bushmeat Liaison Group. Technical Series No. 60, Montreal

Warner SL (1965) Randomized Response: A survey technique for eliminating evasive answer bias. J Am Stat Assoc 60:63–69.

Wright SJ, Stoner KE, Beckman N, et al (2007) The Plight of Large Animals in Tropical Forests and the Consequences for Plant Regeneration. Biotropica 39:289–291.

Supplementary material

S1 Table. Questionnaire used to investigate hunting of mammals by rural residents living in protected areas and a buffer zone in northeastern Atlantic Forest, Brazil.
Part I: Socioeconomic information
Age: Duration of residence: Level of formal education: Household size: Income: Government assistance: ( ) yes; ( ) no Livestock: ( )yes; ( ) no
Part II: Respondents' perceptions regarding wildlife and hunting activities in the villages
In recent years, do you think that hunting has decreased or is still the same in region? Which animals are the most hunted by people in this region? Do you think that abundance of wild animals has changed compared to 10 years ago? ( ) increased; ( ) decreased. Which animals decreased or disappeared? Which animals increased? Why do you think these animals have decreased or increased? Do you recognize the wild animals in the photographs? These animals occur on this region?
Parte III: Information about hunting
Do you hunt (actively) in this area? Why? Which strategies do you use? ( ) firearm; ( ) dog; ( ) trap; ( ) hunting platform; ( ) other Do you capture a wild animal if you find it opportunistically? Do you hunt for sport? Do you kill a wild animal that cause damage to plantations or livestock? Do you use wild animals for medicinal purposes? Do you sell wild meat? How much is a wild meat? When was the last time that you ate a wild meat? Which animal was? What is your favorite wild meat? Do you eat monkeys, sloths and porcupines? Why not?

S2 Table. Recognition of species by respondents using photographs. Also shown perception of species occurrence according to respondents.

	Positive recognition	**Perception of positive occurrence**			
		UWR	UBR	SLNP	BZ
Armadillo	100%	100%	100%	100%	100%
Paca	100%	74%	83%	100%	98%
Collared peccary	100%	80%	94%	100%	98%
Opossum	100%	79%	67%	78%	87%
Deer	100%	60%	76%	33%	81%
Golden-Headed Lion Tamarin	99%	77%	94%	78%	60%
Coastal Black-Handed Titi	92%	84%	83%	89%	77%
Yellow-Breasted Capuchin	67%	20%	56%	67%	46%
Northern Brown Howler Monkey	53%	7%	29%	0%	8%
Maned sloth	96%	74%	94%	89%	92%
Thin-spined porcupine	84%	66%	59%	89%	67%
Painted Tree-rat	56%	13%	18%	11%	17%

S3 Table. Wild meat prices cited by respondents. * Current exchange US$ 1 = R$ 0.26 (Brazilian real). ** The highest prices are given to selling wild meat to people from bigger cities or to famous hotels in the region.

Species	**Prices (US$)***	
	Entire animal	**kg**
Paca	20-129**	6-10
Armadillo	5-21**	6
Collared peccary	-	3
Coati *(Nasua nasua)*	-	4

S4 Table. Candidate models associating socioeconomic factors with hunting and Akaike information criterion (AIC) values.* Minimal adequate model with the lowest AIC value.

Candidate models	**AIC**
Education + Location + Age + Duration of residence + People living at home + Government Assistance + Presence of livestock	232.35
Education + Location + Age + Duration of residence + People living at home + Presence of livestock	230.36
Education + Location + Duration of residence + People living at home + Presence of livestock	228.39
Education + Location + Duration of residence + Presence of livestock	226.77
Education + Location + Livestock	225.32
Education + Location	223.89
Education*	223.57

S5 Table. Candidate models associating socioeconomic factors with consumption of species and Akaike information criterion (AIC) values.

* Minimal adequate model with the lowest AIC value. Parameters: EDU (education), LOC (location), RES (duration of residence), PEO (people living at home), ASSI (government assistance), AGE (respondent's age), GEN (genre).

Species	Candidate models	AIC
Paca	AGE + LOC + GEN + RES + EDU + ASSI + PEO	250.68
	AGE + LOC + GEN + RES + EDU + ASSI	249.02
	AGE + LOC + GEN + RES + EDU	247.56
	AGE + LOC + GEN + RES	245.25
	AGE + LOC + RES	243.66
	AGE + LOC	243.3
	LOC*	242.17
Armadillo	AGE + LOC + GEN + RES + EDU + ASSI + PEO	250.63
	AGE + LOC + GEN + RES + EDU + PEO	248.76
	AGE + LOC + GEN + RES + EDU	247.14
	AGE + LOC + RES + EDU	245.17
	LOC + RES + EDU	244.06
	LOC + RES	240.37
	RES*	238.76
Collared peccary	AGE + PEO + RES + LOC + ASSI + EDU + GEN	236.64
	AGE + PEO + RES + LOC + ASSI + EDU	234.49
	AGE + RES + LOC + ASSI + EDU	233.09
	AGE + LOC + ASSI + EDU	232.36
	AGE + LOC + EDU	231.5
	AGE + EDU	230.8
	AGE*	228.9

CAPÍTULO 3

BEHAVIOURS AND ATTITUDES OF RURAL RESIDENTS TOWARDS WILDLIFE AND ENVIRONMENTAL POLICIES IN PROTECTED AREAS OF THE NORTHEASTERN ATLANTIC FOREST

(Manuscrito formatado nas normas da revista Environmental Conservation)

Behaviors and attitudes of rural residents towards wildlife and environmental policies in Protected Areas of the Northeastern Atlantic Forest

SUMMARY

Protected areas have become a vital conservation strategy to protect biodiversity; however, conflicts between local people and protected areas may undermine the conservation goals. In an attempt to understand these conflicts and improve management in these areas, attitudinal research has been developed across the world. Using 169 direct interviews, we investigated behaviors and attitudes of rural residents towards conservation policies in three protected areas of the Brazilian Atlantic Forest, located in the southern Bahia region. We found that respondents have favorable attitudes towards nature conservation. However, negative attitudes reflected dissatisfaction with the prohibition and restriction on the use of natural resources and highlighted their inclination to perform unfavorable behaviors towards wildlife and environment conservation, such as hunting and forest replacement for small-scale agriculture. We also found a high prevalence of unfavorable behaviors implying that local residents' compliance with the current conservation policies was weak. The results suggested that favorable attitudes and higher levels of formal education of respondents may be good predictors for positive behaviors, while conflicts with wildlife and perception of law enforcement may not. Increasing local support and compliance with policies of the protected areas is necessary for the long-term efficacy of these areas, and to achieve this, it is needful to engage with local people, while guaranteeing residents that their concerns will be included in the management strategies.

Keywords: Brazil, conservation policies, hunting, local people, protected area management, use of resources

INTRODUCTION

Protected areas (PAs) have become a vital conservation strategy to protect biodiversity. However, conflicts between local people and PAs, particularly related to restrictions on the use of natural resources (Heinen 1993; Nepal & Weber 1995; Kideghesho *et al.* 2007), have undermined conservation goals. To tackle this issue, in the last decades, involvement of local residents in the creation and establishment of PAs and better sharing of benefits have increasingly been incorporated into the global policies of PAs (McNeely 1994; Naughton *et al.* 2005). Consequently, growing attention has been focused on a deeper understanding of the relationship between local people and PAs. Studies have investigated the relationship between local people and PAs (e.g. Infield 1988; Holmes 2003; Baral & Heinen 2007) and between people and wildlife through attitudinal and behavioral research (e.g. Hill 1998; Gillingham & Lee 2003; Treves & Karanth 2003; Wang & Macdonald 2006). Studies investigating attitudes and perceptions of local people have contributed towards identification of residents' aspirations and opinions regarding conservation issues (Badola *et al.* 2012). Understanding attitudes and beliefs of local communities towards PAs may help to plan efficient environmental policies (Infield 1988) and is essential to strengthen local support for conservation, which plays an important role in the long-term maintenance of these areas (McNeely 1994; Fialo & Jacobson 1995; Allendorf 2007). Authors have also suggested that attitudes can be good predictors of behavior, along with the understanding of social, cultural and economic factors (Abbot *et al.* 2001; Holmes 2003).

The growing scientific literature indicates that restrictions placed on the use of resources usually result in negative attitudes and problems for management of the PAs (Fialo & Jacobson 1995; Kideghesho *et al.* 2007; Andrade & Rhodes 2012). Conflicts between local populations and wildlife within PAs have also negatively influenced people's attitudes towards wildlife conservation (Parry & Campbell 1992; Hill 1998). In addition, the level of dependence of local residents on natural resources (Sah & Heinen 2001; Baral & Heinen 2007; Marshall *et al.* 2010), perceptions of benefits that protected areas represent (Allendorf *et al.* 2006), and social factors such as demographic and socioeconomic variables (Infield 1988; Wilson 1992; Newmark *et al.* 1993; McBeth & Foster 1994; Allendorf *et al.* 2006) may also influence peoples' attitudes and perceptions.

In Brazil, as many areas designated as PAs are occupied by people, conflicts between inhabitants and PAs are a common problem (Arruda 1999; Abakerli 2001; Ferreira 2004; Ferreira & Freire 2009). There is also growing concern with the increased levels of human-wildlife conflicts over the last decade (Marchini *et al.* 2015). Studies have suggested that negative human-wildlife interactions have threatened the conservation of species within and outside the Brazilian PAs (Conforti & Azevedo 2003; Zimmermann *et al.* 2005). In the Cerrado region, Ferreira & Freire (2009) suggested that people who rely on natural resources have more negative perceptions towards PAs, because the restrictions negatively affected their livelihoods. Engel *et al.* (2014) reported that fishermen had negative perceptions towards the Ilha dos Lobos Wildlife Refuge and sea lions (*Otaria flavescens*) in southern Brazil, because they considered the presence of this species as an obstacle to their fisheries activities. On the other hand, Mintzer *et al.* (2015) found that fishermen who participated in research and ecotourism programs in the Mamirauá Sustainable Development Reserve in the

Amazon had more positive attitudes towards river dolphins (*Inia geoffrensis*); but they did not report a significant association between attitude and behavior related to the river dolphin conservation.

We investigated the behaviors and attitudes by rural residents towards PAs and conservation policies in three PAs of the Brazilian Atlantic Forest, located in southern Bahia. The Brazilian Atlantic Forest is considered a high priority conservation region, supporting a high number of endemic species (Myers *et al.* 2000). Approximately 12% of the original Atlantic Forest cover remains and around 9% of its remaining fragments is under protection (Ribeiro *et al.* 2009). Although conservation initiatives have increased over the past decades, investments to ensure biodiversity conservation in Atlantic Forest continue to be scarce (Tabarelli *et al.* 2005). Illegal practices, including hunting and deforestation, persist to negatively impact the remaining areas, resources are insufficient to manage protected ones (Galindo-Leal & Câmara 2003) and efforts to effectively engage local communities in planning and management of PAs are still scarce (Diegues & Vianna 1995; Arruda 1999). Management strategies vary between the three investigated PAs and the buffer zone. The Una Biological Reserve and the Una Wildlife Refuge are longer-established and law enforcement and management efforts have been conducted in both areas (IBAMA 1997, Santos and Blanes 1999), while in the more recent established Serra das Lontras National Park and its buffer zone management actions are still scarce. Our study aimed at identifying (1) residents' attitudes towards the PAs and conservation policies; (2) residents' behaviors related to wildlife and environment conservation; (3) factors influencing people's attitudes; and (4) factors representing good predictors of behaviors. We expected that attitudes and prevalence of behaviors would vary depending on the location; specifically we expected to find a higher prevalence of unfavorable attitudes and behaviors in the newest PA and

in its Buffer Zone area, compared to inside the longer-established PAs. We also expected that a combination of factors, such as attitudes and socioeconomic factors, may be influencing people's attitudes and behaviors. Understanding the attitudes and factors affecting behaviours related to nature conservation may assist managers to prioritize their actions to mitigate conflicts between residents and PAs and improve people's compliance with PAs policies.

METHODS

Study area

This research was conducted in three PAs (Una Biological Reserve, Una Wildlife Refuge and Serra das Lontras National Park) and a buffer zone located mostly in the municipalities of Una and Arataca in southern Bahia, Brazil (Fig. 1).

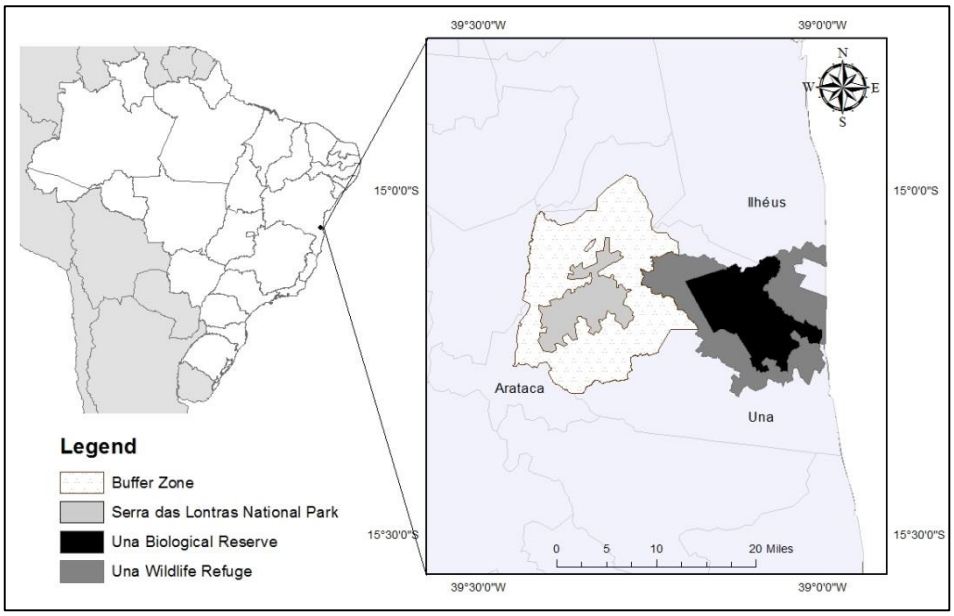

Figure 1 Study area composed of three protected areas and a buffer zone in southern Bahia, Brazil.

Una Biological Reserve (UBR, World Conservation Union [IUCN] category Ia) was originally created in December 1980, with an area of 11,500 ha, to protect the remaining forest fragments in Southern Bahia and save the threatened golden-headed lion tamarin (*Leontopithecus chrysomelas*). Following expansion in 2007, the Reserve now extends across 18,500 ha in area, comprising one of the largest remnants of the Atlantic Forest in southern Bahia (Schroth *et al.* 2011). Una Wildlife Refuge (UWR, IUCN category III) was the former UBR's Buffer zone. It was established in December 2007, covering an area of 23,404 ha. Serra das Lontras National Park (SLNP, IUCN category II) was established in June 2010, with an area of 11,336 hectares. The Park comprises one of the last remnants of the Montane Atlantic Forest in northeastern Brazil (Schroth *et al.* 2011), which are crucial for the conservation of the endemic bird species *Acrobatornis fonsecai* (Pacheco *et al.* 1996). The Buffer Zone (BZ) comprises an area of 58,796 hectares, located around the SLNP. There are approximately 970 properties inside the four areas.

The National System of Conservation Units' law (Art. 10 and 11 Federal Law 9.985/2000) states that all private areas within UBR and SLNP limits must be expropriated, while in UWR, private landownership is permitted, as long as the land use is compatible with conservation goals of the PA. If this condition is violated, private land must also be expropriated in UWR (MMA 2000). The expropriation involves payment for the rural property (including infrastructure and improvements to the land), in case the owner possesses the land title, or the compensation for existing improvements in the area, in case the individual has possession, but does not own a land title (MMA 2007). According to the Chico Mendes Institute for Biodiversity Conservation (ICMBio), the body responsible for managing all Federal PAs,

expropriation of private properties within SLNP´s boundaries is yet to be initiated. In UWR, no expropriations were made and in UBR, 51% of properties were expropriated.

Legislation and PAs policies

According to the Federal Law (Law 9605/98 - Law of Environmental Crimes), hunting is forbidden in all the Brazilian territory, except in a case of necessity to satisfy the hunger of a person. However, inside strictly PAs hunting is totally forbidding. When residents claim and prove that hunting has occurred for subsistence, managers consider this information in light of the law enforcement report and judgment will be meted out. With respect to secondary forest replacement for agriculture, replacing primary or secondary forest in the initial or more advanced stages for agriculture is banned within the PAs. Normally, only fallow and unused lands can be considered for replacement and requires formal authorization. The use of fire is forbidden in UBR and requires formal authorization in UWR and SLNP. The utilization of wood in SLNP requires formal authorization and is forbidden in UWR and UBR. Fishing is banned in UWR and UBR but permissible in the SLNP, limited to only dams formerly regulated and constructed prior to the creation of the Park.

Data collection

Data were collected from October 2012 to June 2014. Properties were randomly selected in the three PAs (UBR, UWR and SLNP) and in the BZ connecting these areas, based on data obtained from ICMBio containing 650 georeferenced properties. We also delineated a complementary opportunistic sample to cover part of properties absent in the ICMBio data, which accounted for more 320 properties. We could not access all properties of the four areas for safety reasons, as some were located in places with

difficult access or in conflict areas under dispute between indigenous people and farmers.

Semi-structured interviews were conducted with only one person per property either with the landowners or workers, men or women, available during the visit. Whenever possible, interviews were done in the presence of a local field assistant, to ensure greater confidence between the interviewee and researcher. This research was authorized by the Ethics Committee (State University of Santa Cruz - CAAE: 03600412.0.0000.5526) and managers responsible for the PAs (SISBIO-ICMBio: 34574-1). All interviews were conducted with the consent of respondents and confidentiality was assured. Only one person declined to participate in the direct interviews. However, although we took into consideration all the interviews, it was soon evident that most respondents were not comfortable discussing sensitive behaviors like hunting and deforestation.

The questionnaire included closed-ended questions to gather information regarding: (1) Social factors and territorial information: gender, age, level of education, duration of residence, household size, government assistance *("Bolsa Família"*), occupation, territorial extension, presence of forest and livestock, (2) knowledge of PAs, (3) attitudes towards PAs, (4) attitudes toward wildlife and environment conservation, (5) behaviors toward wildlife and environment conservation, (6) perception about law enforcement, (7) perceptions on hunting and deforestation occurrence in the community, and (8) conflicts with wild animals (crop damage or livestock loss). In addition, open-ended questions were used to investigate respondents' perception about PAs. Subsequently, we classified perceptions of PAs in positive (perception of benefits), negative (perception of costs) and both (perception of costs and benefits).

Attitude and behavior assessment

Attitude was defined as the degree to which a person has a favorable or unfavorable evaluation of a specific behavior (Ajzen 1991). In this study, respondents needed to agree or disagree with the statements made on conservation-related perceptions. When a respondent did not completely agree with the statement, citing a condition for agreement, we considered that respondent partly agree with the statement. We investigated attitudes towards PAs and nature conservation, attitudes related to wildlife laws and use of resources. Respondents were also questioned about behaviors that they currently perform within the study area. These behaviors were related to practices involving wildlife and environment conservation. To explain attitudes and verify good predictors for behaviors, association between several factors assessed was verified, as shown in Table 1.

Table 1 Factors assessed to explain attitudes and behaviors. UBR= Una Biological Reserve; UWR= Una Wildlife Refuge; SLNP= Serra das Lontras National Park; BZ= Buffer zone.

Factors	***Categories***
Location	UBR-UWR; SLNP-BZ.
Perception of PAs	Respondent had positive perceptions of the PAs; respondent had negative perceptions of the PAs.
Conflict with wildlife	Wildlife caused damage to the respondent; wildlife did not cause damage to the respondent.
Perception of illegal activities occurring in the community	Perception of high prevalence of hunting and deforestation occurring in the community; perception of low prevalence of hunting and deforestation occurring in community.
Perception of law enforcement	Respondent perceived no law enforcement; respondent perceived law enforcement; respondent perceived higher frequency of law enforcement.
Social factors	
Level of formal education	Illiterate; primary education; middle school; high school – college.
Government assistance	Respondent received government assistance; respondent did not receive government assistance.
Duration of residence	Continuous or categorical variable (0-10; 11-30; 31-62 years).
Household size	Continuous or categorical variable (1-3; 4-6; 7-21 people).
Age	Continuous or categorical variable (18-40; 41-60; 61-84 years old).

First, we verified the effects of perception of PAs and conflicts with wildlife on attitudes. We also assessed possible links between attitudes and behaviors with social

factors, location, and perception of illegal activities occurring in the community. . The effects of law enforcement on behaviors were also verified. . Finally, we tried to relate specific attitudes with respective behaviors (Fig. 2).

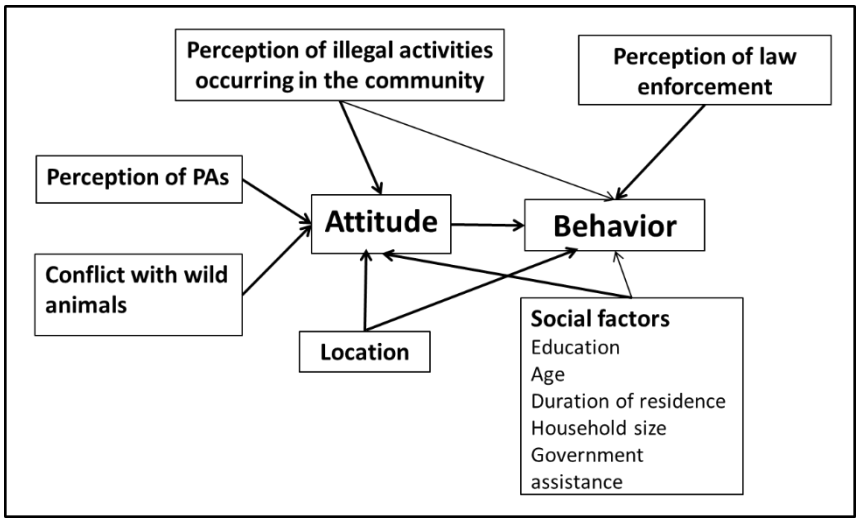

Figure 2 Diagram showing the variables assessed to explain attitudes and behaviors.

Data analysis

We grouped UBR with UWR and SLNP with BZ to statistically compare the data between locations due to had lower numbers of interviews in two of the areas (UBR and SLNP). This grouping was done based on the proximity of the areas and history of PAs' creation. UWR used to be the UBR's buffer zone and management activities usually have occured in both areas (IBAMA 1997). In addition, the expanded area of UBR, where most of UBR residents live, was created at the same time as UWR, while SLNP and its buffer zone were created more recently.

Data were analyzed using R software (R Core Team 2014). The relationship between social factors and location was verified using Pearson X^2 (Contingency Tables) and Wilcoxon tests. Pearson X^2 and Fisher tests were employed to verify association among several categorical variables: between attitudes and behavior with location; perception of PAs and attitudes; law enforcement and behaviors; conflict with wildlife

and attitudes; perception of illegal activities occurring in the community and behaviors; and attitudes and behaviors. To verify association between social factors and attitudes with three category levels (agree, partly agree and disagree) we used Pearson Chi-square (Contingency Tables) and Fisher tests. In this case, the continuous explanatory variables (social factors) were transformed in categorical variables: age (18-40; 41-60; 61-84 years old), duration of residence (0-10; 11-30; 31-62 years); household size (1-3; 4-6; 7-21 people). However, to verify if the binary response variables (attitudes - agree or disagree and behavior – yes or no) were affected by continuous (age, duration of residence and household size) and categorical (education, government assistance) explanatory variables, we used Generalized Linear Models (Logistic Ancova). We performed a model simplification using ANOVA to find the minimal adequate model to describe the data.

RESULTS

We performed 169 interviews with rural residents, of which 74% were men and 26% were women (Table 2). The UWR-UBR properties have a median area of 20 hectares (minimum of 1 and maximum of 1844) whereas the properties in the SLNP-BZ have a median area of 45 hectares (minimum of 3 and maximum of 700). Eighty-four percent of the properties where we conducted the interviews had some area of secondary forest preserved and 68% of the properties had livestock.

Sixty percent of respondents were aware that they were living inside or near a PA. In UWR-UBR, 46% of respondents knew about the PA compared with the 78% in SLNP-BZ (X^2 = 17.84, df = 1, $p<0.001$). This difference was mainly because people living in an area of the UBR, that was expanded in 2007, rejected the fact that the area

they were residing belonged to the UBR. Besides, many people from UWR knew about the UBR but did not realize that the area they were living in was part of the UWR.

Table 2 Demographic and socioeconomic variables of respondents in protected areas of Southern Bahia. UWR= Una Wildlife Refuge; UBR= Una Biological Reserve; SLNP= Serra das Lontras National Park; BF= Buffer Zone; W= Wilcoxon test; X^2= Pearson Chi-square; *p<0.05.

	UWR-UBR (n=94)	SLNP-BZ (n=75)	Total (n=169)	test	p
Mean age (± SD)	51 ± 15.6	49 ± 15.6	50 ± 15.6	W = 3271.5	0.42
Duration of residence (± SD)	18 ± 14.6	20 ± 17.8	19 ± 16.1	W = 3509.5	0.71
Household size (± SD)	4 ± 2.9	3 ± 2.1	4 ± 2.5	W = 3516	0.98
Education				X^2 = 9.03	0.03*
Illiterate	50%	27%	40%		
Primary	26%	43%	34%		
Middle school	12%	15%	13%		
High school - College	12%	15%	13%		
Occupation				X^2 = 0.89	0.34
Related to agriculture	90%	85%	88%		
Government assistance				X^2 = 3.12	0.08
Yes	54%	41%	48%		

Attitudes

With respect to the PAs, respondents revealed conflicting perceptions with respect to the costs and benefits of these areas to their lives. Thirty-eight percent of them perceived benefits and costs, 33% perceived only costs and 29% perceived only benefits. The costs most cited by respondents were related to the prohibition of forest replacement for small-scale agriculture and expropriation of residents, while the benefits most cited related to nature conservation, protection of water bodies, forests and animals (Table 3).

Table 3 Respondents' perception regarding costs and benefits offered by the protected areas.

Benefits	***Citations*** *(n=166)*
Conserve nature	42
Protect springs and water bodies	41
Protect wild animals	33
Protect forest	19
Improve the rainfall regimes	10
Improve people's health	4
Costs	
People cannot work, as it is prohibited to replace forest with agriculture	69
People must relocate / government does not pay a fair value for the properties	18
Increase of dangerous animals	10
Logging is forbidden, neither for use within the property	9
It is not allowed to do anything	7
Increase in unemployment	4
Hunting is prohibited	4
Residents have neither support nor information	3
Usage of fire is prohibited	2
Enforcement agents bother people	2
Wild animals cause damage to plantations	1

More than half of respondents disagreed with respect to the need for strictly PAs (no residents allowed) to protect nature. Respondents believe that there is no necessity to separate people and nature. They expressed that it is possible to live within these areas and conserve nature with government assistance (benefits/ support and information/ awareness). They also complained that the government do not pay fair value for the properties and people are harmed and forced to leave anyway. On the other hand, all respondents agreed in protecting nature for the future and acknowledged that they are also responsible for that (Table 4).

With respect to respondents' attitudes towards wildlife laws, in general, people agreed with the law to protect wild animals, but most of them thought that the law could be more flexible. Some respondents believed that the law should prohibit hunting for commercial purposes, but permit hunting for consumption. They also suggested that a hunting season could be allowed for hunting of abundant species. Some respondents

cited that dangerous species should not be protected by law. On the other hand, other respondents declared that without protection by law, wild animals would completely disappear. Confirming the general opinion that hunting for consumption should be permissible, most people agreed that only trade-hunters should be punished by law (Table 4).

Finally, regarding respondents' perceptions of the use of resources, most respondents agreed with hunting for consumption. Many respondents quoted a religious justification such as "God made wild animals for us to eat" or "God left wild animals to feed the poor". However, some declared that hunting should be permissible only for subsistence. People who disagreed advocated that if hunting for consumption was allowed, wild animals would probably disappear. Besides, some respondents felt that at present it is not necessary any more to subsist on wild meat; people could raise animals and enjoy more job opportunities to earn money. There was a barely significant difference for this attitude between locations: people in the SLNP-BZ agreed more with allowing hunting for consumption. Almost all respondents disagreed that hunting for sale should be allowed. Half of respondents agreed with retaliation (killing animals that caused damage). Most of them declared that they would kill the animal if it was considered a good wild meat for consumption, and if not they would scare the animal away. Some respondents that disagreed suggested that plantation areas could be fenced off or wild animals be scared away, but most believed that government/ PA managers should either assist residents to avoid such conflicts or compensate people for wildlife damage. More than half of respondents believed that it is not right to keep wild animals in captivity, whereas the other half felt that there is no problem to have a wild animal at home if you can take care of it. With respect to replacing forest with small scale agriculture, respondents of UWR-UBR significantly agreed more with this attitude,

whereas those of the SLNP-BZ partly agreed, citing that only secondary forests or restricted areas, particularly those not close to water bodies, should be allowed (Table 4).

Table 4 Attitudes related to protected areas and conservation policies, and the relation between attitudes and location. UWR= Una Wildlife refuge; UBR= Una Biological Reserve; SLNP= Serra das Lontras National Park; BF= Buffer Zone; X^2= Pearson Chi-square test; * p<0.05.

	UWR-UBR			***SLNP-BZ***			
Attitude Statements	***Agree***	***Partly Agree***	***Disagree***	***Agree***	***Partly agree***	***Disagree***	***P value (X^2-Fisher test)***
Perception of Protected Areas and nature conservation							
1. Protected Areas improve respondents' quality of life (n=163) Condition: Positive and negative feelings	27%	40%	33%	30%	41%	29%	0.80
2. Strictly Protected Areas are necessary (n=166) Condition: Only if people are paid fair to leave the area.	38%	1%	61%	32%	4%	64%	0.42
3. Nature should be protected for the future and the coming generations (n=166)	100%	-	-	100%	-	-	-
4. Residents are responsible for protecting nature (n=166) Condition: Government is also responsible.	98%	1%	1%	99%	-	1%	-
Perception of wild animal conservation laws							
5. Law to protect wild animals is necessary (n=167) Condition: Law should be more flexible.	21%	78%	1%	11%	87%	2%	0.09
6. People who hunt should be punished (n=159) Condition: Only people who sell wild meat.	14%	79%	7%	7%	87%	6%	0.35
Perception of resource use							
7. Hunting for consumption should be allowed (n=168) Condition: Only when necessary for subsistence.	65%	15%	20%	81%	8%	11%	0.07
8. Hunting for sale should be allowed (n=167) Condition: If the person needs money to buy food.	-	-	100%	1.5%	1.5%	97%	-
9. Retaliation should be allowed (n= 159) Condition: Kill if the animal is good for consumption.	40%	9%	51%	33%	17%	50%	0.32
10. Keeping wildlife as pets should be allowed (n=162)	48%	-	52%	38%	-	62%	0.19
11. Replacing forests with small scale agriculture should be allowed (n=168) Condition: Only secondary forests or limited areas far away from water bodies.	50%	41%	9%	28%	61%	11%	0.01*

Behaviors

Our investigation on behaviors showed that one-third of respondents have replaced secondary forests with small-scale agriculture. Despite the desire to perform the behavior some respondents stated that they did not replace secondary forests with small-scale agriculture either because it was prohibited or because they did not know if

it was allowed. Respondents have replaced pasture areas with tree plantations (e.g. coconut, banana and rubber), cassava plantations or left the forest to regenerate. They have also planted native or exotic fruit trees on their properties. Sixty-three percent of respondents have used fire occasionally and most of them admitted to doing a firebreak ("aceiro"). Wildlife kept as pets usually included birds (songbirds and parrots). But other mammal species like the collared peccary (*Pecari tajacu*) and kinkajou (*Potos flavus*), and reptiles (*Chelonoidis carbonaria*) were also found. People admitted to have kept other wild animals as pets in the past, such as the golden-headed lion tamarin (*Leontopithecus chrysomelas*), maned sloth (*Bradypus torquatus*), nine-banded armadillo (*Dasypus novemcinctus*), crab-eating fox (*Cerdocyon thous*) and the Bahia hairy dwarf (*Coendou insidiosus*).

Respondents admitted to occasionally hunting wild animals for subsistence, but mostly because they enjoyed wild meat. We also found that respondents from SLNP-BZ hunt more. More respondents from the SLNP-BZ admitted to using wood on the property. They were found to have used fallen or dry trees, trees from shade cocoa (*cabrucas*) and secondary forests to build cocoa drying areas, fences and houses. Some of them acknowledged having legal authorization for this activity. Others complained that they could not use any wood because it is prohibited. Despite most respondents having used firewood, 37% of them said to also use cooking gas. Medicinal plants were widely used, although the use of wild animals for medicinal purposes appears to have decreased over time. At present, species still used in popular medicine according to respondents are pacas, porcupines (especially the Bahia hairy dwarf porcupine), lizards and armadillos. The bile of paca is used to treat snakebites, diabetes and back pain; paca hair is used to cure strokes. Porcupine quills are also used to treat strokes. Lizard fat is used to cure earache and sore throat. Armadillo tail is also used to treat earache.

Respondents in SLNP-BZ use more fish as a food resource. People occasionally fish in the rivers near their properties or dams. However, three respondents admitted that there were fewer fishes in some rivers because other people had poisoned the water (Table 5)

Table 5 Proportion of respondents performing behaviors related to wildlife and environment conservation in protected areas and buffer zone of the Atlantic Forest. The relationship between behaviors and location is also shown. UWR= Una Wildlife Refuge; UBR= Una Biological Reserve; SLNP= Serra das Lontras National Park; BF= Buffer Zone; X^2=Pearson Chi-square test; *p<0.05.

	UWR-UBR	***SLNP-BZ***	***p value* (X^2)**
Replacing forest with small scale agriculture (n=165)	32%	31%	0.82
Replacing pasture with crops / agroforestry (n=157)	19%	17%	0.72
Plant trees on the property (n=164)	70%	62%	0.24
Use of fire (n=160)	68%	55%	0.08
Use of wood for construction (n=149)	60%	78%	<0.001*
Firewood gathering (n=149)	88%	79%	0.13
Gathering of medicinal plants (n=149)	90%	94%	0.38
Medicinal use of wild animals (n=149)	19%	21%	0.76
Hunt wild animals (n=169)	46%	61%	0.04*
Retaliation (kill animals that cause damage, n=72)	15%	22%	0.45
Keep captured wild animals as pets (n=163)	21%	15%	0.40
Fishing	30%	51%	0.01*

Factors influencing attitudes and behaviors

Positive PA perception related to favorable attitudes towards conservation

Positive perceptions of PAs were related to favorable attitudes towards hunting (Fisher test, p = 0.03), favorable attitudes towards retaliation (X^2 = 9.56, df = 4, p = 0.05) and favorable attitudes towards replacing forest with small scale agriculture (Fisher test, p = 0.001). But no association was found with the attitude of keeping wild animals as pets (X^2 = 1.28, df = 2, p = 0.53). This implies that people who have a positive perception towards PAs usually have favorable attitudes towards wildlife and environment conservation.

Conflicts between people and wildlife (crop damage and livestock losses)

Forty-nine percent of respondents declared experiencing problems with wildlife that caused damages to their plantations and / or livestock loss, especially chickens. Many mentioned having given up raising animals because of these problems. Wild animals usually causing livestock loss or crop damage include *Pecari tajacu* and *Hydrochoerus hydrochaeris* (which destroy cassava and corn plantations) and carnivore species (e.g. *Cerdocyon thous, Leopardus* sp., *Procyon cancrivorus, Didelphis aurita, Eira barbara, Boa constrictor*) which consume chickens and their chicks. We did not identify any association between people who suffered damage and their attitude towards the PA (X^2 = 1.19, df = 2, p = 0.55). No association was found either between people who have experienced damage and their attitude (X^2= 4.2607, df = 2, p-value = 0.12) and behavior (Fisher test, p-value = 0.58) of retaliation. We also compared people who experienced damage with the attitude (X^2 = 0.19, df = 2, p = 0.91) and behavior of hunting (X^2= 0.78, df = 1, p = 0.37), but no association was found.

Effect of social factors on attitudes and behaviors

From the eleven attitudes investigated, five revealed a link with social factors (Tables 6 and 7) and, among the 12 behaviors assessed, six showed a relationship with social factors (Table 8). Only significant interactions are shown in Tables.

Table 6 Relationship between attitudes (three category levels: agree, partly agree or disagree) and social factors (categorical variables). X^2= Pearson Chi-square, df= degrees of freedom, *p<0.05.

Attitudes	***Social factors***		
	Primary education	Lower duration of residence	Middle-age
Agreed with permission to hunt for consumption	Fisher test, p=0.005*	Fisher test, p=0.04*	X^2= 9.534, df=4, p=0.05*
Agreed with retaliation	Fisher test, p=0.01*		
Agreed with replacing forest with small-scale agriculture		Fisher test, p=0.02*	

Table 7. Minimal adequate models (Logistic Ancova) showing social factors affecting attitudes (binary response: agree or disagree). * p<0.05

	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**
Model 1 – Agreed with the law to protect wild animals				
(Intercept)	-2.7932	0.5948	-4.696	2.65e-06*
Education (Middle school)	1.8769	0.7662	2.450	0.01430*
Education (High school-College)	2.1001	0.7537	2.786	0.00533*
Education (Illiterate)	1.1068	0.6872	1.611	0.10727
Model 2 – Disagreed with keeping wildlife as pets				
(Intercept)	0.99886	0.32057	3.116	0.00183*
Household size	-0.19647	0.07789	-2.523	0.01165*

In general, we found that the education level was the most significant social factor affecting the response variables, interacting with three attitudes and four behaviors. Most associations revealed that respondents with lower levels of formal education (illiterate or primary education) tended to have more unfavorable attitudes and perform more negative behaviors. Other social factors such as duration of residence, household size, government assistance and age related to three, two, one and one response variables, respectively. Attitude related to hunting and behavior related to firewood gathering were the only variables to interact with more than one social factor.

Table 8 Minimal adequate models (Logistic Ancova) showing social factors affecting behaviors (binary response: yes or no). * p<0.05

	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**
Model 1 – Pasture replacing for agroforestry				
(Intercept)	-2.08851	0.36130	-5.781	7.45e-09*
Duration of residence	0.02799	0.01304	2.146	0.0319*
Model 2 – Use of fire				
(Intercept)	0.6633	0.2985	2.222	0.0263*
Education (Middle school)	-0.1778	0.5395	-0.330	0.7417
Education (High school-College)	-1.0688	0.5454	-1.960	0.0500*
Education (Illiterate)	0.1252	0.4023	0.311	0.7557
Model 3 - Firewood gathering				
(Intercept)	0.9999	0.4463	2.240	0.0251*
Education (Middle school)	-0.5856	0.6699	-0.874	0.3821
Education (High school-College)	-0.5647	0.6532	-0.864	0.3873
Education (Illiterate)	1.2835	0.6648	1.931	0.0535*
Government assistance (yes)	1.3092	0.5357	2.444	0.0145*
Model 4 – Hunting				
(Intercept)	0.6109	0.2850	2.144	0.0320*
Education (Middle school)	-0.7062	0.5216	-1.354	0.1758
Education (High school-College)	-1.3041	0.5436	-2.399	0.0164*
Education (Illiterate)	-0.7651	0.3783	-2.022	0.0431*
Model 5 - Retaliation				
(Intercept)	-0.4700	0.4031	-1.166	0.244
Education (Middle school)	-1.1394	1.1673	-0.976	0.329
Education (High school-College)	-1.1394	1.1673	-0.976	0.329
Education (Illiterate)	-2.7881	1.0959	-2.544	0.011*
Model 6 – Fishing				
(Intercept)	-1.2100	0.3364	-3.597	0.000322*
Household size	0.2064	0.0791	2.610	0.009063*

Perception of illegal activities occurring in the community influencing behavior

According to respondents' perceptions on deforestation, 54% believed that forest areas are increasing, 31% believed that the situation remains the same (deforestation has stopped) and 15% believed that forests continue to decrease (deforestation is ongoing). The perception of forests increasing is barely higher among respondents of UWR-UBR (X^2 = 4.93, df = 2, p = 0.08). No relationship was identified between the perception of deforestation and attitude towards replacing forests with small-scale agriculture (Fisher test, p = 0.47). However, we found that the perception of deforestation was related to the behavior of replacing forests with small-scale agriculture (X^2 = 5.80, df = 2, p=

0.05), indicating that respondents who perceived decreasing forests tended to deforest more.

With respect to hunting activities, 56% of respondents perceived a reduction in hunting activities in their villages, whereas 44% said that hunting remains the same. More respondents in UBR-UWR perceived a decrease in hunting compared with those of SLNP-BZ (X^2 = 4.26, df=1, p= 0.04). No association was found between the perception of hunting and attitude regarding permitting hunting for consumption (X^2 = 0.071, df = 2, p = 0.96). However, an association was found between perception and behavior (X^2 = 8.94, df = 1, p= 0.002), showing that people who perceived a reduction in hunting activities hunted less, whereas people who perceived hunting to continue hunted more.

Effects of law enforcement on behaviors

Forty-nine percent of respondents believed that there is law enforcement active in their villages, 35% commented that law enforcement is low or inexistent and 16% related that patrols have increased over the last years. A difference between the perception of law enforcement and location was observed. People in SLNP-BZ perceived lower frequency of law enforcement (X^2 = 51.64, df = 2, p < 0.001). Eight respondents complained about PA employees, indicating that they were neither prepared to talk with residents nor listen to them; others complained that law enforcement agents acted inappropriately, persecuting residents. On the other hand, four respondents mentioned that recently PA staff had started to inform and guide people instead of only controlling and punishing. With respect to the effects of law enforcement on behaviors, no association was identified between law enforcement and behaviors such as hunting (X^2 = 3.56, df = 2, p = 0.16), replacing forest with small-scale agriculture (X^2 = 1.25, df

= 2, p = 0.53), keeping wildlife as pets (X^2= 0.75, df = 2, p-value = 0.69) and retaliation (Fisher test, p= 0.65). On the other hand, an association was found between perception of law enforcement and the use of wood for construction. Respondents who perceived an increased frequency of law enforcement have used less wood (X^2= 13.25, df = 2, p = 0.001).

Favorable attitudes predicting favorable behaviors

We found that in general, favorable attitudes were associated with favorable behaviors. People who disagreed with retaliation killed fewer animals that cause damage than those who agreed (X^2 = 22.4663, df = 1, p<0.001). Respondents who disagreed with keeping wildlife as pets had less wildlife as pets than those who agreed (X^2 = 12.544, df = 1, p<0.001). Respondents who disagreed with the permit to hunt for food hunted less than those who agreed (X^2 = 14.261, df = 2, p<0.001). However, no association was found between the attitude and behavior of forest replacing with small-scale agriculture (X^2 = 1.95, df = 2, p = 0.37).

DISCUSSION

In general, similar attitudes were observed between respondents in UBR-UWR and SLNP-BZ. However, with respect to behaviors, respondents in SLNP-BZ revealed significantly more hunting, fishing and use of wood than those in UBR-UWR. We found that all respondents have favorable attitudes towards nature conservation for the future. However, negative attitudes towards PAs were related to perception of costs associated mostly with the restriction of resource use and expropriation of residents. This finding corroborates with Kideghesho *et al.* (2007) who found that costs related to conservation, especially with respect to prohibitions or restrictions on the use of natural

resources negatively influenced attitudes of local populations. This result is important because relocating local communities from PAs without adequate compensation and restricting them access to natural resources without considering their needs can increase negative attitudes towards PAs and result in failure to protect biodiversity in the long-term (Andrade & Rhodes 2012).

Our results for attitudes towards wildlife conservation suggested that most respondents have a strong desire to hunt for consumption, and they also admitted high levels of performance of hunting, especially in SLNP-BZ. This is a big issue because it goes against the PAs policies and the Federal law. Despite that, only two people agreed with commercial hunting, showing that respondents in both locations do not support the desire to hunt for improving income. This interesting and favorable finding to wildlife conservation could be used by the PA managers to improve strategies to combat illegal hunting and wild meat trade in those areas. Regarding retaliation, respondents showed divided opinions, although once again, the desire for wild meat consumption appeared to support the desire to kill an animal that caused damage. Despite the law, hunting has widespread prevalence in Brazil (Alves & Souto 2011; Carvalho & Morato 2013; El Bizri *et al.* 2015) and is considered a constant problem within the PAs of Bahia State (Schiavetti *et al.* 2013). Research conducted in the study region have shown that hunting is a common practice (Pereira & Schiavetti 2010; Flesher & Laufer 2013), including hunting of threatened species (Castilho *et al.* 2013). The activity is also pointed as a potential reason for reducing abundance or even extirpating mammal species in the area (Pardini *et al.* 2009; Cassano *et al.* 2012). On the other hand, another finding favorable to wildlife conservation was that less than half of respondents wished to keep wildlife as pets, and the actual rate of behaviour performance was even lower,

probably because residents are aware that keeping captive wildlife is forbidden and they fear of being apprehended with a wild animal at home.

Another significant result was related to the attitude and behavior of replacing forest with small-scale agriculture. Considering that most respondents are involved in agricultural activities, the biggest complaint from them was that they were restricted from replacing secondary forests with small-scale agriculture, which hindered their work and livelihood. This feeling was reflected in negative attitudes towards the PAs and forest conservation, and one-third of respondents also admitted to having replaced secondary forest with small-scale agriculture. According to PAs policies, only areas that do not classify as forest in the initial or more advanced stages of regeneration are subject to authorization for clear-cutting. According to SOS Mata Atlântica & INPE (2015), deforestation rates of Atlantic Forest have reduced compared with recent years, but Bahia State was the third state with highest deforestation rates. Between 2012 and 2013 the municipality of Una lost 46 ha of forest based on this Atlantic Forest mapping. Moreover, according to PA managers, illegal deforestation has been registered during law enforcement events recently conducted in UBR and UWR. This conflict represents a great challenge for PAs management, because reconciling land use and biodiversity conservation within PAs require precautionary measures to ensure protection of the remaining fragments, without harming residents' livelihood.

Respondents demonstrated some caution with respect to environment conservation, explaining their behaviors by using preventive measures, in the case of fire usage (e.g. firebreaks), by using dry wood (e.g. firewood and wood) or stating they had secured legal permission (e.g. wood usage for construction). However, high prevalence of unfavorable behaviors suggests that part of respondents did not comply with the PAs policies, considering that most of these practices necessitated

authorization by the PA managers or had been completely prohibited. In addition, while some respondents complained about the laws, stating they were being persecuted and restricted from doing their work, others were confused regarding the laws, requesting information about what was permitted and what was prohibited. This was an interesting finding, as it revealed that some respondents felt oppressed by the laws and the control exerted by PA staff, and that information about regulations for resource utilization were lacking. Although the relationship between respondents and PA employees was not directly investigated, we think that this interaction deserve further investigation in the future, considering that favorable attitudes can be influenced by good relationships between PA staff and local people (Newmark *et al.* 1993; Ormsby & Kaplin 2005; Anthony 2007).

Predictors of attitudes and behaviors

Our results suggested that a combination of factors may contribute to explaining respondents' attitudes and behaviors in the study region. In general, respondents with a positive perception of the PA generally presented more favorable attitudes towards wildlife and environment conservation. Allendorf *et al.* (2006) showed that perception of benefits is a good predictor for favorable attitudes. With respect to human-wildlife conflicts, studies have suggested that previous negative interaction with wildlife can explain residents' negative attitudes towards wildlife (Parry & Campbell 1992; Naughton-Treves *et al.* 2003) and PAs (De Boer & Baquete 1998). However, this association was not identified either for attitude or behavior. Despite the desire to kill and anger expressed by some respondents due to their losses, others who experienced losses revealed positive awareness towards human-wildlife interaction, understanding the need and opportunity for animals to feed. Moreover, factors like fear of punishment

(enforcement) or desire to consume certain wild animals causing damage could contribute to perform the behavior or not. Liu *et al*. (2011) suggested that human-wildlife conflicts may influence the attitude towards bears (*Ursus thibetanus*) in China, but not necessarily the behavior.

In addition, we identified that social factors, apart from influencing attitudes, are also significant in shaping behaviors. Formal education levels proved to be the most important social factor in shaping attitudes and behaviors towards conservation. Those with higher educational levels evidently tended to have more favorable attitudes and, consequently, favorable behaviors. Several studies have linked higher education levels with more favorable attitudes toward conservation (e.g. Infield 1988; Wilson 1992; Newmark *et al.* 1993; Sah & Heinen 2001), and with lower dependency on natural resources (Gunatilake 1998; Marshall *et al.* 2010). Therefore, actions that support and incentive school attendance by local residents of the PAs and the BZ, especially efforts that guarantee infrastructure and access to middle and high-school, besides the primary education, are essential to improve attitudes and behaviors towards conservation in PAs. In the short-term, environmental education and communication programs can help to avoid conflicts over the use of natural resources and improve awareness towards potential benefits brought by the PAs (Ormsby & Kaplin 2005). Unlike other studies which identified a relationship between long-term residents and negative attitudes (e.g. Newmark *et al.* 1993), we found that short-term respondents had more negative attitudes towards conservation in the PAs. This relation could be due to the long-term respondents being more attached to their areas, valuing the wildlife and natural environments more (Ferreira & Freire 2009), or because the long-term respondents possibly have experienced, and felt the impact of the consequences from large-scale deforestation and overhunting that had been prevalent in the region prior to the creation

of the PAs. For instance, problems with dry soil damaging crops occurred when deforestation was done along the rivers. Age, household size and government assistance were also related to some specific attitude or behavior. Middle-aged respondents agreed more with hunting for consumption than the younger and older respondents. This relation could possibly be explained as age and education showed slight correlation, with half of the middle- aged respondents having primary education, another factor influencing attitudes. Fishing was related to respondents having more people living at home, possibly because large families might require alternate protein sources to complement their diets. Firewood gathering was related to respondents receiving government assistance. In specific regions of the Atlantic Forest, firewood usage is strongly associated with the poorest local communities (Aguiar *et al.* 2003), who are the candidates normally receiving the assistance.

Besides social factors, we found that attitudes and perception of illegal activities occurring in the community may also be good predictors of behavior, while perception of law enforcement was not good. According to the Theory of Planned Behavior (Ajzen 1991) designed to predict and explain human behavior, a function of intentions composed by attitudes, subjective norms (perception of social pressure to perform the behavior or not) and perceived behavioral control (perception of respondents about the ease or difficulty of performing a behavior) can predict a behavioral performance. Our results can be partly explained by this theory. In our study, respondents with favorable attitudes towards conservation generally revealed positive behaviors. Besides, respondents who perceived a higher prevalence of illegal activities occurring in the community (which could represent a subjective norm) were also involved on illegal behaviour performance. However, we found that perception of law enforcement (which could represent a behavioral control) only influenced one behavior. Possibly, the

enforcement did not affect most behaviors because patrols were not frequent in the study region. In addition, the existing enforcement could not be enough to prevent negative behaviors because the activities performed involved the use of resources essential to the local communities' livelihood (De Boer & Baguete 1998). Contrary to this finding, Mintzer *et al.* (2015) suggested that behavioral control such as enforcement could explain why fishermen stopped killing river dolphins within a PA. In their work, law enforcement was also considered ineffective although it was suggested that an enforcement agent program developed by the PA managers training residents as agents could contribute towards the reduction of illegal activities.

Finally, location of respondents had a minimum influence on attitudes, suggesting that time and differences in establishment of the PAs did not change opinion or perceptions of local people towards conservation policies. However, with respect to behaviors, respondents from SLNP-BZ admitted higher proportion of unfavorable behaviors, such as hunting and use of wood. A higher prevalence of hunting in SLNP-BZ could be associated with the higher number of respondents from these areas having primary education, another factor that was related to the higher prevalence of hunting. The higher prevalence of wood usage could be associated with a greater perception of weak law enforcement in SLNP-BZ, considering that this behavior was associated with perception of law enforcement.

Management implications

To increase compliance with conservation policies in the PAs, it is essential to engage local people to a greater extent, guaranteeing that residents and their concerns will be included in the management strategies (Andrade & Rhodes 2012). Actions should capitalize on positive attitudes that people already have (e.g. respondents'

favorable attitude towards commercial hunting) and attempt to mitigate the negative ones (Allendorf *et al.* 2006). Programs of educational development should be implemented to guarantee that residents living in and around the PAs have access and incentives to attend school, especially to higher grades of school. In addition, communication mechanisms can help to improve awareness among residents (Ormsby & Kaplin 2005; Ferreira & Freire 2009; Masud *et al.* 2014) and to improve positive contact between staff of the PAs and local people (Newmark *et al.* 1993). Special attention should be paid to inform residents regarding the objectives and benefits of the PAs, and the ways to get permission to use resources, as we identified that this information was lacking among respondents. Information needs to be provided in an easily accessible form, especially for those who are illiterate. In addition, improving law enforcement can help to better control illegal activities inside and around the PAs. However management actions should also prioritize training PAs agents in social skills to interact and solve conflicts with local residents.

To raise compliance with the restriction imposed on forest replacing with small-scale agriculture, managers of the PAs should plan strategies to improve support for small farmers through technical assistance, financial incentives or benefits that could mitigate the impact of restrictions and prohibitions on people's livelihood. For instance, studies developed in southern Bahia region have highlighted that cocoa plantations shaded by native trees (*cabrucas*), one of the principal economic crops of the region, play an important role in providing favorable conditions for biodiversity conservation, along with forest fragments (Faria *et al.* 2007; Cassano *et al.* 2009; Schrot *et al.* 2011). Based on this information, management strategies could support actions to increase economic returns from *cabrucas* to the small farmers, by assisting in agricultural diversification of other shade-tolerant crops, improving efficiency in the cocoa trade by

the removal of the middle-men in the export process (Franzen & Mulder 2007), and encouraging environmental certification of production (Franzen & Mulder 2007; Schroth *et al.* 2011). Moreover, supporting the creation and strengthening of small farmers' associations to market local products could also bring benefits to local people (De Boer & Baguete 1998).

CONCLUSION

Our results suggested that in general favorable attitudes and higher levels of formal education of respondents were good predictors of positive behaviors. However, negative attitudes reflected dissatisfaction with prohibition and restrictions on the use of natural resources and also highlighted people's desire to perform unfavorable behaviors towards wildlife conservation. Moreover, the high prevalence of unfavorable behaviors towards conservation suggested that compliance of local residents with the current PAs policies is still weak. Changing the attitudes and behavior related to hunting is a complex task, because it includes social, cultural and economic aspects. Consequently, raising compliance with conservation policies in PAs is challenging, particularly if we consider that managers have scarce human and financial resources to implement PAs (Galindo-Leal & Câmara 2003; Schiavetti *et al.* 2013). However, to achieve long-term effectiveness of the PAs, it is widely accepted that local communities should support these areas and their conservation policies (e.g. McNeely 1994; Fialo & Jacobson 1995; Allendorf 2007). A useful approach could involve a combination of strategies, such as education programs (Milner-Gulland *et al.* 2003; Cassano *et al.* 2009; Gandiwa 2011; Melo *et al.* 2014), diversifying livelihood activities and protein sources (Loibooki *et al.* 2002; Bitanyi *et al.* 2012) apart from improving law enforcement efforts (Hilborn *et al.* 2006).

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References

Abakerli, S. (2001). A critique of development and conservation policies in environmentally sensitive regions in Brazil. *Geoforum* **32**: 551:565.

Abbot, J.I.O., Thomas, D.H.L., Gardner, A.A., Neba, S.E. & Khen, M.W. (2001) Understanding the links between conservation and development in the Bamenda Highlands, Cameroon. *World development* **29**(7): 1115-1136.

Aguiar, A.P., Chiarello, A.G., Mendes, S.L., De Matos, E.N. (2003) The Central and Serra do Mar Corridors in the Brazilian Atlantic Forest. In: *The Atlantic Forest of South America: biodiversity status, threats, and outlook*, ed. C. Galindo- Leal & I.G. Câmara. Washington, DC: Center for Applied Biodiversity Science and Island Press.

Ajzen, I. (1991) The Theory of Planned Behavior. *Organizational behavior and human decision processes* **50**: 179-211

Allendorf, T., Swe, K.K., Oo, T., Htut, Y., Aung, M., Allendorf, K., Hayek, L., Leimgruber, P. & Wemmer, C. (2006) Community attitudes toward three protected areas in Upper Myanmar (Burma). *Environmental Conservation* **33**(4): 344-352.

Allendorf, T.D. (2007) Respondents' attitudes toward three protected areas in southwestern Nepal. *Biodiversity and Conservation* **16**(7): 2087-2102.

Alves, R.R.N. & Souto, W.M.S. (2011) Ethnozoology in Brazil: current status and Perspectives. *Journal of Ethnobiology and Ethnomedicine* **7**:22

Andrade, G.S.M. & Rhodes, J.R. (2012) Protected areas and local communities: an inevitable partnership toward successful conservation strategies? *Ecology and Society* **17**(4): 14.

Anthony, B. (2007) The dual nature of parks: attitudes of neighbouring communities towards Kruger National Park, South Africa. *Environmental Conservation* **34**(3): 236–245.

Arruda, R. (1999) Populações tradicionais e a proteção dos recursos naturais em Unidades de Conservação. *Ambiente & Sociedade* **5**: 79-92.

Badola, R., Barthwal, S. & Hussain, S.A. (2012) Attitudes of local communities towards conservation of mangrove forests: A case study from the east coast of India. *Estuarine, Coastal and Shelf Science* **96**: 188-196.

Baral, N. & Heinen, J. (2007) Resources use, conservation attitudes, management intervention and park-people relations in the Western Terai landscape of Nepal. *Environmental Conservation* **34**(1): 64–72.

Bitanyi, S., Nesje, M., Kusiluka, L.J.M., Chenyambuga, S.W. & Kaltenborn, B.P. (2012) Awareness and perceptions of local people about wildlife hunting in western Serengeti communities. *Tropical Conservation Science* **5**(2): 208-224.

Carvalho, E.A.R & Morato, R.G. (2013) Factors affecting big cat hunting in Brazilian protected areas. *Tropical Conservation Science* **6**(2): 303-310.

Cassano, C.R., Schroth, G., Faria, D., Delabie, J.H.C. & Bede, L. (2009) Landscape and farm scale management to enhance biodiversity conservation in the cocoa producing region of southern Bahia, Brazil. *Biodivers Conserv* **18**: 577–603.

Cassano, C.R., Barlow, J. & Pardini, R. (2012) Large Mammals in an Agroforestry Mosaic in the Brazilian Atlantic Forest. *Biotropica* **44**(6): 818–825.

Castilho, L.C., Martinez, R.A., Giné, G.A.F., Ribeiro, G.C. & Schiavetti, A. (2013) The thin-spined porcupine, *Chaetomys subspinosus* (Rodentia: Erethizontidae), within protected areas in the Atlantic Forest, Brazil: local knowledge and threats. *Tropical Conservation Science* **6**(6): 796-810.

Conforti, V. & Azevedo, F. (2003) Local perceptions of jaguars (Panthera onca) and pumas (*Puma concolor*) in the Iguaçu National Park area, south Brazil. *Biological Conservation* **111**: 215–221.

De Boer, W. & Baquete, D.S. (1998) Natural resource use, crop damage and attitude of rural people in the vicinity of the Maputo Elephante Reserve, Mozambique. *Environmental Conservation* **25**(3): 208- 218.

Diegues, A.C. & Vianna, L.P. (1995) *Conflitos entre populações humanas e unidades de conservação e Mata Atlântica.* São Paulo: NUPAUB-USP.

El Bizri, H.R., Morcatty, T.Q., Lima, J.J.S. & Valsecchi, J. (2015) The thrill of the chase: uncovering illegal sport hunting in Brazil through YouTube™ posts. *Ecology and Society* **20**(3): 30.

Engel, M.T., Marchini, S., Pont, A.C., Machado, R. & Oliveira, L.R. (2014) Perceptions and attitudes of stakeholders towards the Wildlife Refuge of Ilha dos Lobos, a marine protected area in Brazil. *Marine Policy* **45:** 45–51.

Faria, D., Paciencia, M.L.B., Dixo, M., Laps, R.R., Baumgarten, J. (2007) Ferns, frogs, lizards, birds and bats in forest fragments and shade cacao plantations in two contrasting landscape in the Atlantic forest, Brazil. *Biodivers Conserv* **16**: 2335–2357.

Ferreira, L.C. (2004) Dimensões Humanas da Biodiversidade: mudanças sociais e conflitos em torno de áreas protegidas no Vale do Ribeira, SP, Brasil. *Ambiente & Sociedade* **7**(1): 47-66.

Ferreira, M.N. & Freire, N.C. (2009) Community perceptions of four protected areas in the Northern portion of the Cerrado hotspot, Brazil. *Environmental Conservation* **36** (2): 129–138.

Flesher, K.M. & Laufer, J. (2013) Protecting wildlife in a heavily hunted biodiversity hotspot: a case study from the Atlantic Forest of Bahia, Brazil. *Tropical Conservation Science* **6**(2): 181-200.

Fiallo, E.A. & Jacobson, S.K. (1995) Local Communities and protected areas: attitudes of rural respondents towards conservation and Machalilla National Park, Ecuador. *Environmental Conservation* **22**(3) : 241-249.

Franzen, M. & Mulder, M.B. (2007) Ecological, economic and social perspectives on cocoa production worldwide. *Biodiversity and Conservation* **16**: 3835–3849.

Galindo-Leal, C. & Câmara, I. (2005) *Mata Atlântica: Biodiversidade, ameaças e perspectivas.* São Paulo, Belo Horizonte: Fundação SOS Mata Atlântica, Conservação Internacional.

Gandiwa, E. (2011) Preliminary assessment of illegal hunting by communities adjacent to the northern Gonarezhou National Park, Zimbabwe. *Tropical Conservation Science* **4**(4): 445-467.

Gillingham, S. & Lee, P.C. (2003). People and protected areas: a study of local perceptions of wildlife crop-damage conflict in an area bordering the Selous Game Reserve, Tanzania. *Oryx* **37**(3): 316–325.

Gunatilake, H.M. (1998) The role of rural development in protecting tropical rainforests: evidence from Sri Lanka. *Journal of Environmental Management* **53**: 273–292.

Heinen, J.T. (1993) Park-people relations in Kosi Tappu Wildlife Reserve, Nepal: a socio-economic analysis. *Environmental Conservation* **20**(2): 25–34.

Hilborn, R., Arcese, P., Borner, M., Hando, J., Hopcraft, G., Loibooki, M., Mduma, S. Sinclairet, A.R.E. (2006) Effective Enforcement in a Conservation Area. *Science* **314**: 1266.

Hill, C. M. (1998) Conflicting attitudes towards elephants around the Budongo Forest Reserve, Uganda. *Environmental Conservation* **25**(3): 244-250.

Holmes, C.M. (2003) The influence of protected area outreach on conservation attitude and resource use patterns: a case study from western Tanzania. *Oryx* **37**(3): 305-315.

IBAMA (1997) Plano de manejo Reserva Biológica de Una. Ministério do Meio Ambiente, IBAMA.

Infield, M. (1988) Attitudes of a rural community towards conservation and a local conservation area in Natal, South Africa. *Biological Conservation* **45**: 21–46.

Kideghesho, J.R., Røskaft, E. & Kaltenborn, B.P. (2007) Factors influencing conservation attitudes of local people in Western Serengeti, Tanzania. *Biodivers Conserv* **16**: 2213–2230.

Liu, F., McShea, W.J., Garshelis, D.L., Zhu, X., Wanga, D. & Shao, L. (2011) Human-wildlife conflicts influence attitudes but not necessarily behaviors: Factors driving the poaching of bears in China. *Biological Conservation* **144**: 538–547

Loibooki, M., Hofer, H., Campbell, K.L.I. & East, M.L. (2002) Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. *Environmental Conservation* **29**(3): 391–398.

Marchini, S. & Crawshaw Jr., P.G. (2015) Human–Wildlife Conflicts in Brazil: A Fast-Growing Issue. *Human Dimensions of Wildlife* **20**(4): 323-328.

Marshall, N.A., Marshall, P.A., Abdulla, A. & Rouphael, T. (2011) The Links between Resource Dependency and Attitude of Commercial Fishers to Coral Reef Conservation in the Red Sea. *AMBIO* **39**(4):305-313

Masud, M.M., Kari, F.B., Yahaya, S.R.B. & Al-Aminet, A.Q. (2014) Impact of residents' livelihoods on attitudes towards environmental conservation behaviour: An empirical investigation of Tioman Island Marine Park area, Malaysia. *Ocean & Coastal Management* **93**: 7-14.

McBeth, M.C. & Foster, R.H. (1994) Rural Environmental Attitudes. *Environmental Management* **18**(3): 401-411.

McNeely, J.A. (1994) Protected areas for the 21st century: working to provide benefits to society. *Biodiversity and Conservation* **3**: 390-405.

Melo, R.S., Silva, O.C., Souto, A., Alves, R.R.N. & Schiel, N. (2014) The role of mammals in local communities living in conservation areas in the Northeast of Brazil: an ethnozoological approach. *Tropical Conservation Science* **7**(3): 423-439.

Milner-Gulland, E. J. and Bennett, E. L. 2003. Wild meat: the bigger picture. Trends in Ecology & Evolution 18(7): 351-357.

Mintzer, V.J., Schmink, M., Lorenzen, K., Frazer, T.K., Martin, A.R. & Silva, V.M.F. (2015) Attitudes and behaviors toward Amazon River dolphins (*Inia geoffrensis*) in a sustainable use protected area. *Biodivers Conserv* **24**: 247–269.

MMA (2000). Sistema Nacional de Unidades de Conservação (SNUC). URL http://www.mma.gov.br

MMA (2007) *Informe nacional sobre áreas protegidas no Brasil* / Ministério do Meio Ambiente, Secretaria de Biodiversidade e Florestas, Departamento de Áreas Protegidas. Brasília: MMA.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., Fonseca, G.A.B. & Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature* **403**: 853–845.

Naughton-Treves, L., Grossberg, R. & Treves, A. (2003) Paying for tolerance; rural citizens' attitudes toward wolf depredation and compensation. *Conservation Biology* **17**(6): 1500-1511.

Naughton-Treves, L., Holland, M.B. & Brandonet, K. (2005) The role of protected areas in conserving biodiversity and sustaining local livelihoods. *Annu. Rev. Environ. Resour.* **30**: 219–52.

Nepal, S.K. & Weber, K.E. (1995) Managing protected areas under conditions of conflict. Bangkok, Thailand: HSD Monograph.

Newmark, W.D., Leonard, N.L., Sariko, H.I. & Gamassa, D.G.M. (1993) Conservation attitudes of local people living adjacent to five PAs in Tanzania. *Biological Conservation* **63**: 177–183.

Ormsby, A. & Kaplin, B.A. (2005) A framework for understanding community resident perceptions of Masoala National Park, Madagascar. *Environmental Conservation* **32**(2): 156–164.

Pacheco, J.F., Whitney, B.M., Gonzaga, L.P. (1996) A new genus and species of furnariid (Aves: Furnariidae) from the cocoa-growing region of southeastern Bahia, Brazil. *Wilson Bull* **108**: 397–433.

Pardini, R., Faria, D., Accacio, G.M., Laps, R.R., Mariano-Neto, E., Paciencia, M.L.B., Dixo, M. & Baumgarten, J. (2009) The challenge of maintaining Atlantic forest

biodiversity: a multi-taxa conservation assessment of specialist and generalist species in an agro-forestry mosaic in southern Bahia. *Biol Conserv* **142**: 1178–1190.

Parry, D. & Campbell, B. (1992) Attitudes of rural communities to animal wildlife and its utilization in Chobe Enclave and Madabe Depression, Botswana. *Environ Conserv* 19: 245–252.

Pereira, J.P.R. & Schiavetti, A. (2010) Knowledge and faunal game uses by indigenous hunters "Tupinambá from Olivença" (Bahia). *Biota Neotropica* **10**(1): 175-183.

R Core Team (2014) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Ribeiro, M.C., Metzger, J.P., Martensen, A.C., Ponzoni, F., Hirota, M.M. (2009) Brazilian Atlantic forest: how much is left and how is the remaining forest distributed? Implications for conservation. *Biol Conserv* **142**: 1141–1153.

Sah, J. & Heinen, J. (2001) Wetland resource use and conservation attitudes among indigenous and migrant peoples in Ghodaghodi Lake area, Nepal. *Environmental Conservation* **28**(4): 345-356.

Schiavetti, A., Magro, T.C. & Santos, M.S. (2013) Implementação das unidades de conservação do corredor central da mata atlântica no estado da Bahia: desafios e limites. *Revista Árvore* **36**(4): 611-623.

Schroth, G., Faria, D., Araujo, M., Bede, L., Van Bael, S.A., Cassano, C.R., Oliveira, L.C. & Delabie, J.H.C. (2011) Conservation in tropical landscape mosaics: the case of the cacao landscape of southern Bahia, Brazil. *Biodiversity and Conservation* **20**(8): 1635-1654.

SOS Mata Atlântica & INPE (2015) Atlas dos remanescentes florestais da Mata Atlântica, período 2013-2014. URL http://mapas.sosma.org.br

Tabarelli, M., Pinto, L.P., Da Silva, J.M.C., Hirota, M.M., Bedê, L.C. (2005) Challenges and Opportunities for Biodiversity Conservation in the Brazilian Atlantic Forest. *Conservation Biology* **19**(3): 695–700.

Treves, A. & Karanth, K.U. (2003) Human-Carnivore Conflict and Perspectives on Carnivore Management Worldwide. *Conservation Biology* **17**(6): 1491-1499.

Wang, S. W. & Macdonald, D. (2006) Livestock predation by carnivores in Jigme Singye Wangchuck National Park, Bhutan. *Biological Conservation* **129**: 558–565.

Wilson, G.A .(1992) A survey on attitudes of landholders to native forest on farmland. *Journal of Environmental Management* **34**:117-136.

Zimmermann, A., Walpole, M.J. & Leader-Williams, N. (2005) Cattle ranchers' attitudes to conflicts with jaguar *Panthera onca* in the Pantanal of Brazil. *Oryx* **39**(4): 406–412.

CONCLUSÕES GERAIS

Identificar os mecanismos que influenciam ou promovem a conservação de recursos por populações humanas locais é um instrumento de extrema importância no planejamento de ações para o manejo de espécies da fauna e para garantir a eficácia de áreas protegidas. O presente estudo mostrou uma elevada prevalência de comportamentos desfavoráveis à conservação em APs do sul da Bahia, principalmente no Parque Nacional Serra das Lontras e na sua zona de amortecimento, fato que sustenta a primeira hipótese do trabalho. Dentre os comportamento avaliados, foi identificado que a caça ocorre em toda área de estudo, principalmente para complementar a alimentação dos moradores, seja para subsistência ou para a apreciação da carne de animal silvestre. Apesar da proporção de consumo de espécies ameaçadas ter sido baixa, a caça e o consumo desses animais ocorre e pode representar uma ameaça para a viabilidade de pequenas populações destas espécies. Contrariando a segunda hipótese do trabalho, as atitudes dos moradores das diferentes APs foram similares, sugerindo que diferenças de tempo e manejo das APs podem não ter modificado as atitudes dos moradores. Atitudes negativas refletiram a insatisfação dos entrevistados com a proibição e restrição de uso dos recursos naturais, principalmente por causarem prejuízos aos meios de vida dos moradores, e também destacou o desejo das pessoas em realizar comportamentos desfavoráveis a conservação, como a caça e a substituição de matas e capoeiras por agricultura de pequena escala. Por outro lado, percepções positivas sobre as APs, atitudes favoráveis dos entrevistados e níveis mais elevados de educação formal se mostraram bons preditores de comportamentos positivos, apoiando a terceira hipótese do trabalho. Com base nos resultados, atingir a meta do Plano de Ação Nacional para conservação dos mamíferos da Mata Atlântica Central, que é reduzir a pressão de caça sobre as espécies ameaçadas na região sul da Bahia, não é uma tarefa impossível. No entanto, para atingir este objetivo é necessário envolver e incluir as comunidades que vivem dentro e ao redor das APs nas estratégias de manejo das áreas. Estratégias que incluam programas de educação para fornecer informações sobre o estado de conservação de espécies ameaçadas, que incentivem a diversificação de atividades de subsistência e garantam fontes de proteína podem ser válidas. Além disso,

estratégias que beneficiem os pequenos agricultores através de assistência técnica e apoio às associações poderiam atenuar o impacto das restrições ou proibições relativas à subsistência das pessoas. Ao mesmo tempo, aumentar os esforços de fiscalização é necessário para reduzir a proporção de atividades ilegais realizadas nas áreas. O desenvolvimento de projetos de pesquisa e de monitoramento da biodiversidade de longo prazo dentro da área de estudo também pode auxiliar na redução de atividades ilegais, particularmente se os pesquisadores empregarem moradores locais e investirem tempo interagindo com as pessoas. Melhorar o apoio local e o cumprimento das políticas de conservação em áreas protegidas é necessário para garantir a eficácia dessas áreas a longo prazo e para garantir a conservação das espécies, especialmente as endêmicas e ameaçadas de extinção. Para isso, é essencial construir um consenso sobre a melhor forma de manejar essas áreas a fim de beneficiar tanto a conservação como as comunidades locais.

REFERÊNCIAS

ABAKERLI, S. A critique of development and conservation policies in environmentally sensitive regions in Brazil. **Geoforum**, v. 32, p. 551-565. 2001.

ALEXANDER, S. E. Resident attitudes towards conservation and black howler monkeys in Belize: the Community Baboon Sanctuary. **Environmental Conservation**, v. 27, n. 04, p. 341-350, maio 2000.

ALGER, K.; CALDAS, M. The declining Cocoa economy and the Atlantic Forest of Southern Bahia, Brazil: Conservation attitudes of Cocoa planters. **The Environmentalist**, v. 14, n. 2, p. 107-119, 1994.

ALLENDORF, T. D. Residents' attitudes toward three protected areas in southwestern Nepal. **Biodiversity and Conservation**, v. 16, n. 7, p. 2087-2102, out 2007.

ALLENDORF, T. et al. Community attitudes toward three protected areas in Upper Myanmar (Burma). **Environmental Conservation**, v. 33, n. 4, p. 344-352, dez 2006.

ARRUDA, R. Populações tradicionais e a proteção dos recursos naturais em Unidades de Conservação. **Ambiente & Sociedade** - Ano II, n. 5, p.79-92, 1999.

BARAL, N.; HEINEN, J. Resources use, conservation attitudes, management intervention and park-people relations in the Western Terai landscape of Nepal. **Environmental Conservation**, v. 34, n. 1, p. 64-72, mar 2007.

BITANYI, S. et al. Awareness and perceptions of local people about wildlife hunting in western Serengeti communities. **Tropical Conservation Science**, v. 5, n. 2, p. 208-224, 2012.

BRIGHT, C.; MATTOON, A. New rope for a rainforest. The Atlantic Forest of Brazil may be the first of the world's "biodiversity hotspots" that begins to heal. **World Watch**, v. 14, n. 6, p. 8-16, 2001.

CANALE, G. R. et al. Pervasive defaunation of forest remnants in a tropical biodiversity hotspot. **PLoS ONE**, v. 7, n.8, e41671, 2012.

CAREY, C.; DUDLEY, N.; STOLTON, S. **Squandering paradise?** Gland, Switzerland: WWF International, 2000.

CARVALHO, E. A. R.; PEZZUTI, J. C. B. Hunting of jaguars and pumas in the Tapajós–Arapiuns Extractive Reserve, Brazilian Amazonia. **Oryx**, v. 44, n. 4, p. 610–612, 2010.

CHIARELLO, A.G. Influência da caça ilegal sobre mamíferos e aves das matas de tabuleiro do norte do Estado do Espírito Santo. **Bol. Mus. Biol. Mello Leitão**, n.11/12, p. 229-247, 2000.

CONFORTI, V.; AZEVEDO, F. Local perceptions of jaguars (*Panthera onca*) and pumas (*Puma concolor*) in the Iguaçu National Park area, south Brazil. **Biological Conservation**, v. 111, p. 215–221, 2003.

CULLEN JR, L.; BODMER, E. R.; VALLADARES-PADUA, C. Ecological consequences of hunting in Atlantic forest patches, São Paulo, Brazil. **Oryx**, v. 35, n. 1, 2001.

DE BOER, W. F.; BAQUETE, D. S. Natural resource use, crop damage and attitudes of rural people in the vicinity of the Maputo Elephant Reserve, Mozambique. **Environmental Conservation**, v. 25, n. 3, p. 208–218, 1998.

DI BITETTI, M. S. et al. Differential Responses to Hunting in Two Sympatric Species of Brocket Deer (*Mazama americana* and *M. nana*). **Biotropica,** v. 40, n. 5, p. 636–645, 2008.

FERNANDES-FERREIRA, H. et al. Hunting, use and conservation of birds in Northeast Brazil. **Biodiversity and Conservation**, v. 21, p. 221–244, 2012.

FERNANDES-FERREIRA, H. et al. Hunting of Herpetofauna in Montane, Coastal, and dryland areas of northeastern Brazil. **Herpetological Conservation and Biology**, v. 8, n. 3, p. 652−666, 2013.

FERREIRA, L.C. Dimensões Humanas da Biodiversidade: mudanças sociais e conflitos em torno de áreas protegidas no Vale do Ribeira, SP, Brasil. **Ambiente & Sociedade**, v. 7, n. 1, 2004.

FERREIRA, M.N.; FREIRE, N.C. Community perceptions of four protected areas in the Northern portion of the Cerrado hotspot, Brazil. **Environmental Conservation**, v. 36, n. 2, p. 129–138, 2009.

FIALLO, E. A.; JACOBSON, S. K. Local Communities and protected areas: attitudes of rural residents towards conservation and Machalilla National Park, Ecuador. **Environmental Conservation**, v. 22, n. 3, p. 241-249, 1995.

FOERSTER, S. et al. Correlates of Bushmeat Hunting among Remote Rural Households in Gabon, Central Africa. **Conservation Biology**, v. 26, n. 2, p. 335-344, dez 2011.

GADD, M. E. Conservation outside of parks: attitudes of local people in Laikipia, Kenya. **Environmental Conservation**, v. 32, n. 1, p. 50-63, abr 2005.

GALINDO-LEAL, C.; CÂMARA, I. **Mata Atlântica: Biodiversidade, ameaças e perspectivas.** São Paulo, Belo Horizonte: Fundaçao SOS Mata Atlântica, Conservaçao Internacional, 2005. p. 472

GAVIN, M. C.; SOLOMON, J. N.; BLANK, S. G. Measuring and Monitoring Illegal Use of Natural Resources. **Conservation Biology**, v. 24, n. 1, p. 89-100, 2010.
GILLINGHAM, S.; LEE, P. C. People and protected areas : a study of local perceptions of wildlife crop-damage conflict in an area bordering the Selous Game Reserve , Tanzania. **Oryx**, v. 37, n. 3, p. 316-325, 2003.

GOLDEN, C.D. Bushmeat hunting and use in the Makira Forest, north-eastern Madagascar: a conservation and livelihoods issue. **Oryx**, v. 43, n. 3, p. 386–392, 2009.

GOLDEN, C. D.; WRANGHAM, R. W.; BRASHARES, J. S. Assessing the accuracy of interviewed recall for rare, highly seasonal events: the case of wildlife consumption in Madagascar. **Animal Conservation**, v. 16, n. 6, p. 597–603, 2013.

HEINEN, J.T. Park-people relations in Kosi Tappu Wildlife Reserve,Nepal: a socio-economic analysis. **Environmental Conservation**, v. 20, n. 2, p. 25–34, 1993.

HILL, C. M. Conflicting attitudes towards elephants around the Budongo Forest Reserve, Uganda. **Environmental Conservation**, v. 25, n. 3, p. 244-250, set 1998.

HOCKINGS, K.; HUMLE, T. **Best Practice Guidelines for the Prevention and Mitigation of Conflict Between Humans and Great Apes**. Gland, Switzerland: IUCN/SCC Primate Specialist Group (PSG), 2009. p. 41

HOLMES, C. M. The influence of protected area outreach on conservation attitudes and resource use patterns: a case study from western Tanzania. **Oryx**, v. 37, n. 3, p. 305–315, 2003.

IBAMA. Plano de Manejo da Reserva Biológica de Una. 1997. Disponível em: <http://www.icmbio.gov.br/portal/images/stories/imgs-unidades-coservacao/REBIO Una.pdf> Acesso em: 10 fev 2015.

ICMBIO. Executive Summary of the National Action Plan for the Conservation of Central Atlantic Forest Mammals 2010. Disponível em: <http://www.icmbio.gov.br/portal/images/stories/docs-plano-de-acao/pan-mamiferos-da-mata-atlantica/sumario_mamiferos_mata_atlantica_ingles.pdf> Acesso em: 10 dez 2015.

INFIELD, M. Attitudes of a rural community towards conservation and a local conservation area in Natal, South Africa. **Biological Conservation**, v. 45, n. 1, p. 21-46, 1988.

KIDEGHESHO, J. R.; ROSKAFT, E.; KALTENBORN, B. P. Factors influencing conservation attitudes of local people in Western Serengeti, Tanzania. **Biodiversity and Conservation**, v. 16, p. 2213–2230, 2007.

LAURENCE, W. et al. Averting biodiversity collapse in tropical forest protected areas. **Nature**, v. 489, p. 290-294, set 2012.

LEVI, T. et al. Spatial tools for modelling the sustainability of subsistence hunting in tropical forests. **Ecological Applications**, v. 21, n. 5, p. 1802–1818, 2011.

MARCHINI, S.; CRAWSHAW JR., P.G. Human–Wildlife Conflicts in Brazil: A Fast-Growing Issue. **Human Dimensions of Wildlife**, v. 20, n. 4, p. 323-328, 2015.

MARTIN, A.; CARO, T.; MULDER, M.B. Bushmeat consumption in western Tanzania: a comparative analysis from the same ecosystem. **Tropical Conservation Science**, v. 5, n. 3, p. 352-364, 2012.

MARTINI, A. M.Z.; FIASCHI, P; AMORIM, A. M.; PAIXÃO, J. L. A hot-point within a hot-spot: a high diversity site in Brazil's Atlantic Forest**. Biodiversity and Conservation**, v. 16, p. 3111–3128, 2007.

MCNEELY, J.A. Protected areas for the 21st century: working to provide benefits to society. **Biodiversity and Conservation**, v. 3, p. 390-405, 1994.

MILNER-GULLAND, E. J.; BENNETT, E. L. Wild meat: the bigger picture. **Trends in Ecology & Evolution**, v. 18, n. 7, p. 351-357, jul 2003.

MYERS, N.; MITTERMEIER, R. A.; MITTERMEIER, C. G.; FONSECA, G. A. DA; KENT, J. Biodiversity hotspots for conservation priorities. **Nature**, v. 403, p. 853-858, fev 2000.

NARANJO, E.J.; BODMER, R.E. Source–sink systems and conservation of hunted ungulates in the Lacandon Forest, Mexico. 2007. **Biological Conservation** 138, p. 412 - 420, 2007.

NAUGHTON. The role of protected areas in conserving biodiversity and sustaining local livelihoods. **Annu. Rev. Environ. Resour**., v. 30, p. 219–252, 2005

NEPAL, S. K.; WEBER, K. E. Prospects for coexistence: Wildlife and local people. **Ambio**, v. 24, n. 4, p. 238-245, 1995.

PEREIRA, J. P. R.; SCHIAVETTI, A. Knowledge and faunal game uses by indigenous hunters "Tupinambá from Olivença" (Bahia). **Biota Neotropica** , v.10, n. 1, p. 175-183, 2010.

PERES, C. A.; NASCIMENTO, H. S. Impact of game hunting by the Kayapó of south-eastern Amazonia: implications for wildlife conservation in tropical forest indigenous reserves. **Biodiversity and Conservation** v.15, p. 2627–2653, 2006.

RIBEIRO, M. C.; METZGER, J. P.; MARTENSEN, A. C.; PONZONI, F. J.; HIROTA, M. M. The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation. **Biological Conservation**, v. 142, p. 1141-1153, jun 2009.

SANTOS, G. R.; BLANES, J. Environmental education programme with the community surrounding Una Biological Reserve, Bahia, Brazil. **Dodo**, v. 33, p. 118-126, 1997.

SANTOS, G. R.; BLANES, J. Environmental education as a strategy for conservation of the remnants of Atlantic Forest surrounding Una Biological Reserve, Brazil. **Dodo**, v. 35, p. 151-157, 1999.
SCHIAVETTI, A.; MAGRO, T.C.; SANTOS, M.S. Implementação das unidades de conservação do corredor central da mata atlântica no estado da Bahia: desafios e limites. **Revista Árvore**, v.36, n.4, p.611-623, 2013.

TABARELLI, M.; PINTO, L.; SILVA, J.; HIROTA, M.; BEDE, L. Challenges and Opportunities for Biodiversity Conservation in the Brazilian Atlantic Forest. **Conservation Biology**, v. 19, n. 3, p. 695-700, 2005.

TOPP-JØRGENSEN, E. et al. Relative densities of mammals in response to different levels of bushmeat hunting in the Udzungwa Mountains, Tanzania. **Tropical Conservation Science**, v. 2, n. 1, p. 70-87, 2009.

WANG, S. W.; MACDONALD, D. Livestock predation by carnivores in Jigme Singye Wangchuck National Park, Bhutan. **Biological Conservation**, v. 129, p. 558–565, 2006.

WRIGHT, S. J. et al. The Plight of Large Animals in Tropical Forests and the Consequences for Plant Regeneration. **Biotropica**, v. 39, n. 3, p. 289-291, 2007.

ZIMMERMANN, A.; WALPOLE, M.J.; LEADER-WILLIAMS, N. Cattle ranchers' attitudes to conflicts with jaguar *Panthera onca* in the Pantanal of Brazil. **Oryx**, v. 39, n. 4, p. 406–412, 2005.