THESE

pour l'obtention du Grade de
DOCTEUR DE L'UNIVERSITE DE POITIERS
(Faculté des Sciences Fondamentales et Appliquées)
(Diplôme National - Arrêté du 7 août 2006)

Ecole Doctorale Gay Lussac, Sciences pour l'environnement

Secteur de Recherche : Biologie de l'environnement, des populations, écologie

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ESPECES CHARISMATIQUES, ESPECES LOCALES ET SERPENTS EN EDUCATION A L'ENVIRONNEMENT

Evaluation sur dix pays de la perception des enfants à protéger la faune et importance de l'expérience de terrain

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Directeur de Thèse : Xavier Bonnet

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Soutenue le 6 Octobre 2010
devant la Commission d'Examen

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Remerciements

Je remercie tout d'abord le Conseil Général des Deux Sèvres et la région
Poitou Charente qui ont financé ce travail ainsi que l'école Doctoral Gay Lussac pour m'avoir permis de rester étudiant un peu plus longtemps.

Merci à l'ensemble des membres du Jury pour avoir accepté de réviser ce travail : Stephen Mullin, Luca Luiselli, Lijliana Tomovic, Catherine Souty-Grossey, Didier Bouchon et Xavier Bonnet.

Merci à Vincent Bretagnolle, pour m'avoir accueilli dans le Laboratoire du CEBC

Mes plus profonds et sincères remerciements vont à celui sans qui cette étude n'aurait été réalisée, à celui qui m'a soutenu dans ce projet. Celui qui a été toujours disponible, pour son côté « relax » qui m'a permis de travailler dans des conditions idéales. Celui grâce à qui j'ai appris que pour travailler sérieusement, il ne fallait pas se prendre au sérieux. Celui qui m'a fait découvrir et aimer les serpents à travers la science, et surtout le terrain en Australie, Nouvelle Calédonie, Macédoine… Et puis aussi les cocards, les dents cassés, les bras ensanglantés…. La découverte du clacking, du vélo acrobatique (faire connexion avec dents cassée) ….
Pour tout ça merci à mon chef et ami : Xavier Bonnet.

Merci à l'Office National des Forêts et particulièrement Daniel Barré grâce à qui des centaines d'enfants ont pu découvrir les serpents de la fôret de Chizé.

Merci à Mélanie Papin, Jean Luc Lassay et Gregory Provost de l'Arche de la nature pour leur dévotion et leur collaboration. Merci également à mes amis « ours des Balkans » Rastko Ajtic, Bogoljub Sterijovski, Lijiljana Tomovic, Sonia, Marco, Yelka… pour ces souvenirs inoubliables (ah non en fait plutôt des souvenirs voilés voir très vaporeux…) sur le terrain.

Merci aux collègues « herpetos » et autres qui ont collaboré sur ce projet :
Halpern Balint, José Brito, Jelka Crnobrnja-Isailovic, El Hassan ElMouden, Mehmed Erdogan, Monica Feriche, Juan Miguel Pleguezuelos, Pavol Prokov, Antonio Sánchez, Xavier Santos, Tahar Slimani, Muhammet Uşak, Marco Zuffi.

Merci aux 2635 enfants qui ont gentiment répondu aux questionnaires et sans qui cette étude n'aurait pas de raison. Merci à tous les enseignants qui ont pris un peu de leur temps :

Au Népal **:** Ramji Danji (Dargon public school, tilganga Kathmandu), Bhim Acharya (Ecole de Sauraha, Chitwan), S.K; Thapaliya (Bloomings buds), Anand Acharya.

En France **:** Michèl Place, Hélène, Philippe Roy, Dominique Goriou, Stephanie Rudel, Vincent Barribault, Claudie La Roche, Melle Lorieux, Michel Servant, Marilyn Michaud, Michel Shabroux, Sophie Arnault, Catherine Tricoche, Julien Dugast,

Evelyse Viaud, Claudia Juan, Magalie, Francis, Marie-Odyle Reynaud, Marie-Claude Bourdin, Guillaume Guérin, Béatrice Motard, Virginie Geneau, Mr Julien, Madame Denivillères, Madame Farizon, David L'hommédé, Julien Fièvre. Béatrice Bonamy, Catherine Martins, Morgane Prigent, Alix Bivoit, Armelle Legrand, Rodolphe Bécand.

Et puis à tous ceux de Serbie, Maroc, Espagne, Turquie, Hongrie, Italie, Macédoine, que je ne peux malheureusement pas tous remercier individuellement.

Merci à Véronique Rivault pour avoir relu, corrigé et commenté ce manuscrit, et merci à Marie Simonin pour sa dévotion la plus bienvenue dans les derniers instants de l'écrit.

Aux Herpetos avec qui j'ai fait mes premières armes : François Brischoux, Sarah Fornasiero, Olivier Lourdais, Sophie Lorioux, Michael Guillon, Christian Tiburce.

Merci à mes « p'tits » stagiaires **:** Olivier Berto, Raphael Geay (le cheval des enfants), Thomas Roussel et ses malaises, Jérémy, Marie Pauline et ses gâteaux, Anais Lucas, Margot Ropert et ses bouteilles, Mathieu, Augustin Lansard, Jean-Baptiste Levadoux, Marie Simonin et sa gentillesse, Mathias Perez et Morgane Guéno-Bruneau.

Merci aux « indispensables » du laboratoire : Micheline, Christophe, Evelyse, Delphine, Martine, Jean Jacques, André, Denis et Sylvie.

Merci à tous les chercheurs et étudiants du laboratoire pour la bonne ambiance et les dicussions diverses.
Alex, Mathieu, Vincent LC (mon dédé) ,Vincent L, Adrien, J-B, David, Fred B., Benoit, Boen, Virginie, Clara, Aurélie, Anne Cécile, Morgane, Max, Audrey, Vincent LC (mon dédé) ,Vincent L, Adrien, David, Fred B., Benoit, Boen, Thomas, Paul, Sylvie, Bertrand, …. Charlie, Christophe B, Christophe G. Olivier C. Karine…..
Et tous ceux que j'ai oubliés.

Merci à Rex Cambag source de nombreuses inspirations et largement responsable de la logistique.

Merci à tous les autres, Papa et maman de François, Jean et Daniel, Diane, Zou…
Nico, Greg et Vanessa… pour leur soutien et parce qu'on est pot.

A ma « Pompon », Catherine, merci pour ton soutien notamment dans les deniers instants douloureux de la thèse, merci tout simplement d'être là.

Merci malgré eux à ces trop nombreux ignorants qui tues les serpents par simple bêtise et cruauté mais qui m'ont principalement motivé pour travailler sur ce sujet.

Enfin, je dédie ce travail à mon père, à qui j'aurais temps aimé faire découvrir les serpents, le terrain et ma passion…. ma famille, ma maman Noëlle, ma sœur Stéphanie et mon grand frère Patrice qui m'ont toujours aidé et soutenu dans mes choix et projets.

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1 Introduction

La conservation de la biodiversité, un enjeu majeur

La biodiversité subit aujourd'hui une crise majeure (Pimm and Raven 2000 ; Thomas et al. 2004). Qualifiée de sixième extinction, cette crise touche l'ensemble des organismes vivants des grands mammifères aux insectes (Dunn 2005 ; Fonseca 2009). Son origine anthropique est aujourd'hui avérée (Pimm et al. 1995 ; Baillie et al. 2004). Le taux d'extinction de la biodiversité est aujourd'hui 100 à 1000 fois supérieur à celui estimé pour les 500 derniers millions d'années. La disparition et la dégradation des habitats sont l'une des principales causes, processus notamment dus au changement et l'intensification des pratiques agricoles (Green et al. 2005). Parce que les services (éco systémiques, économiques, monétaire….) rendus par la biodiversité sont immenses, indispensables en fait, le ralentissement du taux actuel d'extinction vers des valeurs « normales » est devenu un enjeu planétaire.

Enrayer le déclin de la biodiversité nécessite la participation de la société au sens large (Hunter and Brehem 2003 ; Lindemann-Matthies and Bose 2008) et de son désir de la protéger (Stokes 2006). La responsabilité de tous doit être engagée, le public peut être acteur en réalisant des actes concrets de protection mais aussi devenir un acteur politique en influençant les initiatives de conservation (Gomez et al. 2004). Il est donc essentiel d'acquérir une bonne appréciation et compréhension des problèmes et enjeux liés à la conservation de la biodiversité (Kellert 1993 ; Hunter and Brehem 2003). Pour cela il est nécessaire d'augmenter les connaissances du public sur les besoins de préserver la diversité biologique (Lindemann-Matthies 2002).

L'éducation à l'environnement

L'année 2010 a été déclarée « année de la biodiversité » par les nations unies (Gregoire 2010). L'éducation à l'environnement (EE) est l'une des armes visant à pallier le déclin des espèces (Article 13 de la CDB 1992 ; Caro et al. 1994 ; Tilbury 1994 ; Wilson 1996b; Bjerke et al. 1998 ; Trombulak et al. 2004 ; Brewer 2006 ;

UNESCO 2008). L'EE doit permettre à long terme de développer chez les citoyens des attitudes positives envers l'environnement, ce qui est loin d'être le cas pour la plupart des habitants de la planète pour lesquels le souci environnemental est secondaire, cosmétique, voire totalement inexistant. L'EE est donc l'une des clés pour promouvoir la compréhension des problèmes de conservation chez le public et pour le convaincre de l'importance de préserver la biodiversité (Caro et al. 1994). Le niveau de la tâche est élevé, par exemple le public a une connaissance limitée du concept de biodiversité et de sa richesse (Lindemann-Matthies 2006 ; Lindemann-Matthies and Bose 2008 ; Randler 2008). Beaucoup d'espèces sont oubliées et négligées, particulièrement les espèces locales (Balmford et al. 2002 ; Lindemann-Matthies 2006). Parce que chacun devrait agir localement de façon concrète, la connaissance des organismes locaux à la base de toute réalisation concrète a une importance vitale (Balmford et al. 2002 ; Barker et al. 2002 ; Lindemann-Matthies and Bose 2008).

Pour être efficace, l'EE doit toucher l'ensemble du public, toutes les catégories sociales et tous les âges. Toutefois, de nombreuses évidences suggèrent que les enfants doivent être ciblés en priorité (Feisinger 1997 ; Jacobson and McDuff 1998 ; Rivas and Owens 1999 ; Kellert 2002 ; Louv 2008). En effet, ils sont particulièrement réceptifs aux messages liés à l'environnement et la biodiversité. Ils sont aussi l'un des meilleurs moyens d'atteindre des adultes. Ils construisent et développent précocement des attitudes positives et un vif intérêt envers la biodiversité pour les porter jusqu'à un âge où ils pourront être acteurs et décideurs. Il est donc important de favoriser la connaissance et l'appréciation des plantes et des animaux dès le plus jeune âge (Kellert 1996). Le rôle de l'éducation scolaire est essentiel car il permet de toucher un nombre élevé d'enfants.

L'un des moyens les plus efficaces pour engendrer l'intérêt vis-à-vis de la biodiversité en général, est l'expérience pratique que l'enfant aura avec une partie de celle-ci, qu'elle se réalise à travers des activités scolaires ou hors période scolaire (Bogner 2003 ; Ballantyne and Packer 2005 ; Stokes 2006 ; Wells and Lekies 2006).

L'expérience concrète à travers l'observation, la manipulation, ou l'approche expérimentale est l'un des moyens les plus efficaces pour susciter le développement cognitif, affectif et l'esprit critique de l'enfant (Kellert 2002 ; Khan 2002). De façon logique, les sorties dans le milieu naturel sont inscrites dans les programmes scolaires comme un élément important de l'éducation à l'environnement.

Cette vue pratique s'oppose à celle déclarative qui consiste à expliquer des concepts globaux aux enfants à travers des enseignements en classe, quelles que soient leurs formes (cours, recherches bibliographiques, jeux, conférences…).

L'extinction de l'expérience et le virtuel

Les médias occupent désormais une place prépondérante dans la vie des enfants (Kellert and Westervelt 1984). La télévision et Internet sont les principales sources d'information sur la biodiversité et sur les problèmes de conservation (Jacobson and McDuff 1998). Que ce soit au sein de la famille ou à l'école, les enfants ont presque tous accès à un écran de télévision ou d'ordinateur – en fait placer chaque écolier devant un écran semble même être devenu un objectif pédagogique majeur de nombreux systèmes éducatifs. Pourtant la véracité des contenus sont rarement soumis à un système de vérification. Dans le cadre scolaire, en réalité, très peu de temps est consacré à l'observation des plantes et des animaux dans leurs milieux naturels (Barker et al. 2002). Les sorties écologiques sont largement orientées vers des visites de stations d'épuration ou de recyclage des déchets – les enfants y voient leurs propres déchets mais pas grand-chose d'autre. Les rencontres avec la nature se limitent au contact avec les images véhiculées par les medias et les livres (Chawla 1994 ; Lock 1997 ; Barker et al. 2002). Globalement, les enfants vivent aujourd'hui une « extinction de l'expérience concrète » (Pyle 1993) avec le réel et la nature. Beaucoup d'entre eux passent plus de temps dans des activités en milieu fermé (par exemple en regardant la télévision) qu'à l'extérieur (Wilson 1996a; White 2004 ; Miller 2005). La

perte de contact des enfants avec le milieu naturel est inquiétante (Kellert 2002 ; Louv 2008) et fait d'ailleurs l'objet d'un mouvement de réaction pour compenser cette carence (Charles et al. 2008). C'est pourquoi l'approche virtuelle dans l'éducation au détriment des activités pratiques est vivement critiquée par différents spécialistes (Kellert 2002 ; Lindemann-Matthies 2005, 2006 ; Prokop et al. 2009) Concrètement, ce changement de rapport au vivant issu de la modernisation de notre société, se traduit par une méconnaissance de la biodiversité qui entoure les enfants en faveur d'organismes virtuels. Un bon exemple est fourni par une expérience au cours de laquelle les enfants ont été capables de reconnaitre la plupart des centaines de Pokémons ainsi que leurs caractéristiques tout en demeurant incapables de reconnaitre les éléments les plus visibles de la faune qui les entourent (Balmford et al. 2002). Braqués sur un monde virtuel, les enfants sont devenus aveugles au monde réel.

Problématique

Au delà des déclarations au sujet des coûts et bénéfices de telle ou telle approche pédagogique en EE, il est nécessaire d'entreprendre des campagnes de mesures qui donneront des éléments palpables et solides. En premier chef, l'évaluation des programmes d'éducation est une étape nécessaire à la mise en place de pratique éducative efficace (Bogner 2003). Par exemple, il est possible que l'utilisation d'une nature virtuelle puisse réduire non seulement la connaissance de la biodiversité, entre autre locale, mais aussi le désir de la préserver (Chipeniuk 1995; Levi and Kocher 1999). Inversement, l'EE par une approche virtuelle telle qu'elle est très largement pratiquée aujourd'hui a peut être la vertu de générer une connaissance élevée des problèmes de perte de biodiversité ? Peut être que, grâce aux médias, les écoliers d'aujourd'hui connaissent et comprennent bien les problèmes de leur environnement proximal ? Mais il est indispensable de tester ces hypothèses au risque de sombrer dans une démarche circulaire et délétère. Dans la perspective de tester des éléments qui visent à donner aux enfants les moyens d'agir en faveur de la biodiversité, la problématique de cette thèse s'oriente vers l'évaluation de l'impact

des médias et de l'éducation scolaire sur la compréhension des enfants vis-à-vis de problèmes de conservation (Knapp and Barrie 2001; Heerwagen and Orians 2002 ; Zoldosova and Prokop 2006).

Les médias (TV, magazines, internet) diffusent très largement des informations et des images au sujet des espèces dites charismatiques (ours polaire, baleine…) pour traiter les thèmes liés à la biodiversité (Clucas et al. 2008). Ces espèces, bien qu'étant hors de portée de l'environnement réel des enfants, sont souvent considérées comme des « bannières ». C'est-à-dire qu'il est admit que leur attractivité va pouvoir bénéficier à d'autres organismes moins populaires. Quelques espèces notamment joueraient ce rôle ; il s'agit généralement des grands mammifères prédateurs, et le terme d'espèce « parapluie » est largement utilisé. L'idée sous jacente est que leur préservation implique celle de leur habitat, qui par conséquent bénéficie à un vaste cortège d'espèces végétales et animales. Cette vision est de plus en plus débattue, particulièrement en EE (Lindemann-Matthies 2006 ; Clucas et al. 2008). Notamment parce rien ne permet de démontrer la validité de l'effet ombrelle d'une espèce charismatique sur un monde qui reste totalement négligé – et que faire de l'immense majorité des écosystèmes et des espèces qui n'ont pas leur parapluie ? L'utilisation de quelques espèces charismatiques signifierait à terme que seuls quelques éléments de la biodiversité méritent d'être protégés.

La question principale de cette thèse, en termes d'éducation, est d'examiner si les espèces charismatiques jouent effectivement leur rôle supposé d'ombrelle ? Autrement dit : est-ce que la médiatisation de ces espèces génère un intérêt pour d'autres espèces et permet aux enfants de mieux connaître les organismes situés sur le pas de leur porte, de développer l'envie de les protéger également ? Si oui, les médias et l'école remplissent leur rôle. Dans le cas contraire, les pratiques scolaires ne permettent pas aujourd'hui de compenser le fait que les enfants passent le plus clair de leur temps enfermés, et les médias s'avèrent incapables de jouer un rôle en EE autre que celui d'alarmer les populations sur l'existence de phénomènes inquiétants et plus ou moins réels.

Quel que soit le résultat de ces investigations, il est essentiel de tester des outils permettant de développer des attitudes positives envers la biodiversité. Dans ce cadre, l'efficacité et la mise en place des sorties de terrain ont besoin d'être explorées (Zoldova and Prokop 2006). En effet, la sortie de terrain est la principale alternative à l'écran de télévision ou d'ordinateur, voire de cinéma (cf. le nombre croissant de films sur le thème de la catastrophe écologique actuelle). Cette thèse aborde donc une autre question : Quel est l'impact d'une expérience concrète avec des êtres vivants, choisis parmi les espèces non-charismatiques, au cours d'une sortie dans le milieu naturel sur l'amélioration des connaissances et le désir de les protéger ?

Objectifs

L'évaluation de programmes d'éducation peut être réalisée grâce à des enquêtes. Dans le cadre de cette thèse les interlocuteurs principaux sont de jeunes écoliers. Dans un premier temps, grâce à l'élaboration et à la diffusion de questionnaires écrits, la connaissance et l'intérêt des enfants (majoritairement âgés de 6 à 12 ans) vis-à-vis de la protection de la biodiversité animale ont été sondés. Les questionnaires se focalisent sur les animaux qui permettent aux enfants d'établir des liens étroits avec la biodiversité et les écosystèmes (Myers and Saunders 2002). Compte tenu des différents facteurs (origines géographique, culturelle, pays, religion… ; Kellert 1984 ; Kellert and Westervelt 1984 ; Dillon et al. 2006 ; Kaltenbor 2006) qui peuvent influencer l'attitude des personnes par rapport à la biodiversité, les sondages par questionnaires écrits ont été réalisés dans 10 pays différents, en Europe, Afrique et Asie. Cette approche ne permet pas de contrôler les facteurs en question, mais elle a l'avantage de les intégrer en grande partie.

Parce qu'il est l'un des types d'animaux les plus concernés en termes d'images négatives, de faiblesse des connaissances et d'abondance de rumeurs infondées, et parce qu'il est le symbole d'une nature mal aimée, négligée, voire qu'il faudrait détruire, le serpent est un modèle approprié pour tester les progrès potentiels d'opérations d'éducation à l'environnement. Le serpent a été utilisé comme un

moyen d'évaluation de l'impact d'une sortie de terrain ; c'est-à-dire que nous avons choisi une des bases les plus difficiles pour organiser des sorties de terrain avec des enfants : organiser des sorties scolaires à la poursuite de serpents, vipères entre autres, dans les ronces et les buissons de notre campagne. Les efforts d'éducation à réaliser en faveur des serpents et des reptiles en général sont indispensables pour assurer leur conservation. Le statut pratique et légal de conservation des serpents est si faible ou ambigu qu'il nécessite à la fois une évaluation de l'état de leurs populations, de la connaissance du public, et le développement d'outils de conservation, particulièrement en termes d'éducation des enfants.

Pour synthétiser, cette thèse vise trois objectifs.

1- Evaluer si l'éducation à l'environnement telle qu'elle est pratiquée permet effectivement aux enfants de connaitre et d'essayer de protéger la biodiversité locale au même titre que les espèces charismatiques.

2- Mesurer l'importance de l'expérience de terrain avec la nature, ici via la découverte des serpents dans leur milieu, sur le développement d'attitudes concrètes et favorables à la biodiversité.

3- Evaluer les tendances du statut de populations de serpents, identifier les principales menaces et des moyens pour permettre leur conservation. Notamment en utilisant l'éducation pour la préservation de la biodiversité.

Structure de la thèse

Avec l'introduction, la thèse est composée de cinq parties principales : le Cadre général, la Méthodologie, les Résultats et discussion, et une Synthèse.

Le cadre général de la thèse donne notamment le contexte bibliographique qui fait appel à différentes disciplines. Résolument tourné vers la conservation, le sujet fait appel aux sciences humaines et à l'écologie. Le sujet de thèse s'intéresse en effet aux relations entre l'homme et la nature dans une perspective de conservation. Ce thème reste très vaste, il inclut par exemple l'importance de l'attitude de l'homme vis-à-vis de l'environnement, la place des espèces dans les stratégies de conservation, le rôle de l'éducation à l'environnement pour la conservation. Toutefois, un groupe zoologique particulier, les serpents, a servi de base pour atteindre différents objectifs ; par exemple pour examiner les interactions entre l'homme et l'animal.

La Méthodologie présente la conception, le développement et la diffusion des questionnaires visant à sonder la perception des enfants envers les animaux. Cette partie présente également le suivi de population des serpents qui a servi de base à la mise en place de la sortie de terrain pour les écoliers.

La section Résultats et discussion présente les trois objectifs de la thèse qui sont chacun abordés sous forme de chapitres. Quatre articles à différents stades d'élaboration y sont présentés et rédigés en englais à des fins de valorisation scientifique. Un résumé en français accompagne chacun des chapitres.

Enfin, une synthèse permet de mettre en valeur les principaux résultats et de dégager des perceptives.

2 Cadre général

2.1 Conservation et attitudes

L'érosion de la biodiversité touche l'ensemble des organismes vivants. Les micro-organismes (bactéries, champignons…), les invertébrés (insectes, mollusques….) sont les êtres vivants les plus largement représentés sur terre, (90% des espèces recensées, Kellert 1993), suivis des plantes, et loin derrière les vertébrés. Chez les vertébrés, la liste rouge de l'IUCN (2010) indique des valeurs en nombres d'espèces menacées qui sont proportionnelles à l'effort des investigations plutôt qu'aux risques réels encourus par chaque taxon : pour les groupes terrestres, les oiseaux sont les plus étudiés (9998), puis les mammifères (5490), les amphibiens (6284), et les reptiles (1672). Face à l'immensité de la tâche pour préserver le plus possible d'espèces, nous sommes tenus d'opérer des choix, les plus objectifs possibles en théorie. Nous verrons que l'attention dont bénéficient certains taxons est en partie issue des attitudes du public qui a tendance à tisser des liens affectifs avec certaines espèces plutôt que d'autres.

2.1.1 Conservation biaisée en faveur de certains taxons

Il est connu que les organismes vivants bénéficient de façon inégale des faveurs du public. La curiosité naturaliste est le premier niveau d'intérêt que l'homme peut porter aux organismes, si l'on ne connait pas, comment peut-on agir ? Néanmoins dès ce niveau, un biais taxonomique est présent. Les oiseaux et mammifères suscitent l'intérêt scientifique beaucoup plus grand que les autres groupes, ce qui entraine un « chauvinisme taxonomique » dans les disciplines scientifiques de l'écologie (Bonnet et al. 2002). Les actions de conservation et les fonds qui y sont alloués reflètent également ce biais (Clark and May 2002 ; Seddon et al. 2005 ; Trimble and Van Aarde 2009). Dans les programmes de réintroduction, ce biais s'exprime de façon hiérarchisée: 1- en faveur des vertébrés ; 2- en faveur des mammifères ; 3- en faveur

des grands mammifères (herbivores, carnivores). Plus largement la conservation priorise les grands vertébrés (Balmford et al. 1996). Les oiseaux bénéficient quant à eux d'un grand nombre d'ONG qui œuvrent en leur faveur, ce qui est très positif, mais cela traduit aussi un manque d'équilibre pour conserver efficacement la biodiversité au sens large (Czech et al. 1998).

Les grands mammifères et les oiseaux représentent une infime partie de la diversité biologique, la majorité des organismes est donc largement négligée. Alors même que les invertébrés sont à la fois les organismes les plus représentés et vraisemblablement les plus menacés, leur statut de conservation est très largement ignoré (Kellert 1993 ; Munoz 2007). Le rôle écologique des organismes et la rareté sont les facteurs les plus importants à considérer pour prioriser la conservation (Czech et al. 1998). Mais par exemple les insectes qui ont un rôle écologique essentiel ne sont pas assez considérés (Kellert 1993 ; Wilson 1987).
L'incohérence ne se limite pas aux invertébrés. Le groupe des amphibiens qui contient proportionnellement le nombre de vertébrés les plus menacés (UICN) devrait être le premier à bénéficier de programmes de conservation. En pratique les efforts restent modestes. Par exemple les zoos qui théoriquement doivent jouer un rôle prépondérant dans la conservation ex-situ, détiennent de façon disproportionnée les grands vertébrés. Pourtant ces animaux s'élèvent moins bien que les petits et la disponibilité en habitat ne permet pas de projet de réintroduction réaliste (Balmford et al. 1996).

Ces exemples soulignent une politique globale de conservation qui n'alloue pas nécessairement la majorité des fonds selon des critères objectifs (Tisdell and Nantha 2007), qui devrait prioriser les espèces les plus menacées et les projets les plus réalistes, mais ne le fait pas. De plus, alors que les actions les plus efficaces sont réalisées à une échelle locale, les politiques de conservation ont tendance à focaliser les sites et les animaux exotiques, probablement pour des raisons de visibilité « publicitaire » (Brewer 2002).

2.1.2 L'importance des attitudes du public dans la conservation

La conservation semble donc se baser sur des critères qui dépassent l'objectivité scientifique. Les attitudes positives dont bénéficient les taxons seraient-elles le déclencheur des décisions ?

Les orientations politiques sont largement dépendantes de l'opinion publique. Dès lors, les attitudes de l'opinion publique envers les enjeux de conservation vont avoir un poids important sur les orientations pour la biodiversité (Tisdell et al. 2006). Cette influence existe à différents niveaux, de la recherche scientifique à la conservation sur le terrain (Jacobson and McDuff 1998 ; Shine and Koening 2001). Par exemple, Czech et Borkhataria (2001), ont montré que différents Partis politiques ont des valeurs en faveur de la biodiversité bien distinctes. Néanmoins, les orientations politiques peuvent influencer en retour le public à travers l'éducation qui est vue comme un moyen pour les décideurs d'assurer le respect, l'application et le maintien de leur décisions (Jacobson and McDuff 1998 ; Gomez et al. 2004).

La prise en compte des attitudes du public envers les espèces est donc un atout pour développer une politique efficace de conservation (Miller and McGee 2001 ; Hunter and Brehem 2003 ; Martín-López et al. 2007 ; Teel and Manfredo 2009). Comme l'indique Fleischner (1990), les décisions de notre monde ne se basent pas sur des hypothèses testées mais sur les sentiments des gens envers un problème. C'est pourquoi des sondages sur la façon dont les enfants perçoivent les problèmes de biodiversité et de conservation sont fondamentaux.

2.1.3 Des attitudes principalement gouvernées par des préférences viscérales

Quel moteur va pousser le public à avoir une attitude favorable envers une espèce, ou l'enclin à la protéger (« Willingness to protect ») ? Quel est le processus à prendre

en compte pour pouvoir changer les attitudes et ainsi redresser le biais taxonomique ?

Différentes études (Kellert and Berry 1980 ; Serpell 2004) ont montré l'existence de deux principales considérations dans le développement des attitudes envers la biodiversité : 1- affectives ; 2- utilitaires (Martín-López et al. 2007). La première est une réponse affective et émotive qu'un animal va pouvoir générer ; la seconde est une perception de l'espèce en tant que valeur économique (Kellert 1996). Cette seconde considération renvoie ainsi à des attributs écologiques et scientifiques. Néanmoins, le sort des espèces et de la biodiversité dépend plus des caractéristiques viscérales, affectives aux yeux du public que les caractéristiques scientifiques (Metrick and Weitzman 1996 ; Martín-López et al. 2007).

Czech et al. (1998) soulignent que l'allocation des bénéfices converge avec le modèle basé sur la construction sociale. Ainsi les oiseaux et les mammifères seraient privilégiés parce qu'ils sont mieux « socialement placés » que les reptiles, amphibiens et invertébrés (Czech et al. 1998). Cette construction sociale serait dès lors basée sur la préférence humaine plutôt que sur des préférences objectives et scientifiques (Kellert and Westervelt 1984). Les espèces qui bénéficient du soutien de l'homme sont plutôt celles qui sont attractives (Gunnthorsdottir 2001 ; Trimble and Van Aarde 2009), comme les lions ou les éléphants (Hunter and Brehem, 2003).

De nombreuses études mettent en effet en évidence ce type de préférence pour les espèces qui ont le plus grand degré de ressemblance avec l'homme, « human like » (Seddon et al. 2005 ; Tisdell et al. 2006). Les critères physiques de similitude sont la taille, la forme du corps et la présence de poils : au sommet les mammifères (singe) à l'opposé des serpents qui n'ont ni bras ni jambes, ou les insectes de petite taille (Lindemann-Matthies 2005). Toutefois, une espèce animale comme végétale peut être également appréciée si elle est esthétique (Martín-López et al. 2007 ; Knight 2008 ; Verissimo et al. 2009). Mais là encore, les préférences s'opèrent pour les espèces de grandes tailles (Ward et al. 1998) possiblement car elles rentrent au mieux dans la spère du visible.

Les préférences viscérales sont également fondées sur des valeurs culturelles (spirituelles, à travers la mythologie, la religion, les poèmes, la littérature), economique ou social (à travers la nourriture locale, la médecine traditionnelle, les rituels… et maintenant l'écotourisme).

2.1.4 Les changements de rapports au vivant

Au cours des dernières décennies, la perception du vivant a radicalement changé (Ballouard 2005). D'ailleurs, l'apparition dans les textes de la protection des espèces et des milieux naturels est le reflet de l'expression d'une nouvelle demande sociale (Wintergest 1994). L'évolution du rapport de l'homme avec l'environnement peut s'illustrer par la mise en jeu d'un changement des représentations de l'homme envers l'animal « sauvage ». Autrefois, dans la société rurale traditionnelle, « animal sauvage » était associé avec nuisible ou dangereux pour l'homme (Micoud 1993a). Aujourd'hui, ces termes correspondent à un sauvage et une nature qui sont désirés (Larrère 1994b). Le statut des grands prédateurs illustrent ce changement. Le loup et l'ours autrefois nuisibles et systématiquement éradiqués sont aujourd'hui des espèces à respecter, voire à protéger (Lambert 1999 ; Micoud 1993b). Dans les zoos on veut toucher l'animal « sauvage », dans la nature on veut le voir. Mais on ne considère pas tous les animaux sauvages de la même façon : certains sont des icones, les autres sont toujours craints et détruits. Les médias accompagnent largement ce changement et entretiennent ces préférences.

2.1.5 La place et l'influence des médias dans notre perception de l'animal sauvage

Aujourd'hui les medias, la télévision et internet en particulier, ont une place prépondérante dans la vie des citoyens (Williams and Handford 1986 ; Hofferth and Sandberg 2001 ; Heerwagen and Orians 2002 ; Wells and Lekies 2006), surtout chez les enfants (Huston et al. 1999). La télévision a un effet significatif sur le

développement des attitudes envers la faune sauvage (Kellert and Westervelt 1984). Certaines espèces y sont exhibées très régulièrement (e.g., l'ours polaire). Les grands mammifères charismatiques suscitent la sympathie du public (Kellert 1993 ; Feldhamer et al. 2002). L'animal à protéger devient une sorte d'animal de compagnie virtuel et collectif (Peloss 1994). On perçoit donc une confusion entre le sauvage et le domestique (Larrère 1994). Ainsi la fabrication du nouvel animal sauvage est issue d'une nouvelle culture où l'animal doit se voir reconnaître une place dans notre cœur (Lambert 1999).

2.2 La place des espèces dans les stratégies de la conservation

L'une des stratégies les plus efficaces pour conserver un maximum d'espèce est de conserver l'habitat. Néanmoins cette approche a ses limites (Shine and Bonnet 2009). Une autre stratégie consiste à s'intéresser aux espèces en particulier. Cependant l'utilisation de ces espèces est limitée, au détriment de la préservation de l'ensemble de la biodiversité, notamment locale et ordinaire.

2.2.1 Espèces ombrelles, clés, indicatrices, charismatiques : quelques espèces pour conserver l'ensemble des organismes ?

Les biologistes de la conservation utilisent souvent une ou un petit nombre d'espèces regroupées sous les termes d'espèces « Focal » (Lambeck 1997) ou d'espèces « Surrogate » (Caro and O'Doherty 1999), espèces de « substitution » en Français. Dans le contexte où la conservation de l'ensemble de la biodiversité est limitée par le temps et les coûts, ces espèces sont employées en tant que raccourcis. L'intérêt pour ces espèces repose sur le fait que leur protection va bénéficier à un maximum d'autres avec un minimum d'effort (Bifolchi and Lodé 2005).

Définitions des termes

Les espèces de substitution englobent celles qui possèdent des particularités bien définies. Nous pouvons distinguer tout d'abord les espèces « clés » qui rendent à l'écosystème un service, agissent sur le maintien de l'équilibre de la biodiversité. Par exemple, un prédateur qui dans le cas où il disparaitrait entrainerait la prolifération d'une espèce. Caro et O'Doherty (1999), ont proposé trois catégories espèces de substitution. Néanmoins ces auteurs n'englobent pas les espèces « clés » si elles n'ont pas de valeur démontrée pour des processus de conservation en général.

1) L'espèce « ombrelle » ou « parapluie ». De nombreuses définitions témoignent d'une confusion autour de la signification de ce terme (Roberge and Angelstam 2004). Une espèce ombrelle peut être utilisée pour délimiter la taille d'une zone ou d'un habitat à mettre sous protection (Caro and O' Doherty 1999). Les grands prédateurs sont typiquement des espèces ombrelles. Leur protection nécessite la protection d'un territoire vital étendu où doit être présent un grand nombre d'espèces avec de petits domaines vitaux et situés à des niveaux trophiques inférieurs (Martikainen et al. 1998).

2) L'espèce « indicatrice ». Ce terme est particulièrement utilisé pour une espèce ou taxon qui est présent dans une zone de haute richesse en biodiversité (Landres et al. 1988). Elle est clairement vue comme une espèce de substitution (Caro and O'Doherty 1999). Au lieu d'échantillonner le nombre total d'organismes sur la zone, quelques taxons sont étudiés, réduisant considérablement les coûts d'échantillonnage (Watt 1998). Typiquement, des espèces indicatrices peuvent être employées en écotoxicologie car elles peuvent permettre de déceler des perturbations environnementales.

3) L'espèce « bannière ». Ce terme repose sur des considérations stratégiques pour attirer l'attention du public (Western 1987 ; Walpole and Leader-Williams 2002). Ce concept se base sur le fait qu'une espèce peut capturer l'imagination du public afin de favoriser l'envie de supporter des actions de conservation, ou de donner des fonds en faveur de nombreux autres organismes (Johnsingh and Joshua 1994 ; Caro and

O'Doherty 1999). Une bannière doit être charismatique, par exemple le Panda géant emblème du WWF (Kontoleon and Swanson 2003).

Les animaux charismatiques sont essentiellement les grands mammifères et les oiseaux (Bowen-Jones and Entwistle 2002 ; Clucas et al. 2008). Dans de nombreux cas des espèces ombrelles peuvent être des bannières jusqu'à en devenir des synonymes (Caro et al. 2004). Par exemple, le tourisme qui vend des séjours grâce à quelques espèces bannières (e.g., Tigre au Népal) a un certain potentiel pour que des fonds soient ensuite transférés à une échelle locale (Walpole and Leader-Williams 2002).

Les limites écologiques de l'utilisation des espèces de substitution

Il existe un débat sur l'utilisation des espèces de substitution (Walpole and Leader-Williams 2002). De nombreuses études ont montré que ce système peut faillir selon deux cas :

1- la présence d'une espèce est utilisée de façon inappropriée pour identifier une zone de conservation Lambeck 1997 ; Simberloff 1998 ; Caro & O'Doherty 1999 ; Andelman and Fagan 2000 ; Zacharias and Roff 2001 ; Caro et al. 2004)

2- la réponse d'une espèce à un changement environnemental ne prédit pas la réponse que d'autres espèces auront face à des perturbations similaires (Oatley et al. 1992 ; McComb et al. 2001 ; Caro et al. 2004). La plupart des critiques ciblent les espèces qui sont sélectionnées pour leur rôle écologique, que ce soit des espèces dites ombrelles (Roberge and Angelstam 2004), clés ou indicatrices (Landres et al. 1988 ; Niemi et al. 1997 ; Rubinoff 2001).

Par exemple, alors que la loutre est largement considérée comme une espèce à la fois ombrelle et charismatique, les résultats de Bifolchi et Lode (2005) ont montré que la biodiversité ne diffère pas entre des sites habités ou non par des loutres.

Sélection des espèces de substitution sur la base *d'a priori*

Globalement, un grand nombre d'étude montre que l'utilisation de raccourcis écologiques peut être erronée (Fleishman et al. 2000). Même si la conservation focalisée sur les espèces prédatrices peut être écologiquement justifiée, les biologistes doivent utiliser les prédateurs supérieurs de façon prudente, leur efficacité dépendant d'un contexte stratégique (Sergio et al. 2005). Par exemple dans le domaine de l'écologie de la restauration, cette approche a eu un succès limité, partout où elle a été appliquée à cause d'un manque de données (Lindemayer et al. 2001).

L'un des principaux problèmes est qu'en théorie la sélection d'une espèce ombrelle est prospective, alors qu'en pratique elle est toujours rétrospective. Les espèces sont suggérées ombrelles, non sur la base de traits écologiques, mais plutôt parce qu'elles sont en danger ou ont un statut de protection fort (Fleishman et al. 2000). Des espèces peuvent même avoir les caractéristiques d'ombrelles sans être pour autant en danger (King and Beazley 2003). Beaucoup d'espèces sont dites de « substitution » alors qu'elles ne répondent pas aux critères de ce concept. Par exemple, une espèce peut être attractive aux yeux du public sans avoir un domaine vital qui englobe clairement celui des autres espèces visées (Caro 2000).

L'emploi limité des espèces bannières

De nombreuses espèces dites bannières sont aussi classées comme « espèces de substitution » alors qu'elles sont de mauvais outils de conservation. Par exemple Caro et al. (2004) ont montré que des espèces bannières comme le jaguar ou le tapir, ne remplissent pas le rôle d'espèces ombrelles. Quelques espèces ombrelles ont effectivement un rôle clé dans un écosystème (e.g., requin blanc) mais ce sont des cas particuliers (Clucas et al. 2008). Globalement, les critiques suggèrent que les termes employés sont souvent mal définis et situés loin des priorités de conservation de l'écosystème. Typiquement les efforts alloués à un programme de réintroduction d'une espèce ne profiteront qu'à l'espèce en question car les moyens ne sont généralement pas utilisés pour préserver ou restaurer l'habitat.

Pour résumer, l'utilisation d'espèces charismatiques ou bannières peut être justifiée dans certains cas, mais le danger principal est que cela se fasse au détriment d'autres actions plus importantes (Simberloff 1998).

2.2.2 La biodiversité commune et locale

Un des principaux dangers est que les espèces communes, locales soient indirectement considérées dans les programmes de conservation, voire totalement ignorées. Pourtant les espèces dites « communes » représentent une biomasse importante, jouent des rôles écologiques clés et sont parfois des espèces patrimoniales (Gaston and Fuller 2008).

Les espèces communes comme éléments clés de l'écosystème

En pratique, la conservation se focalise sur les espèces rares en voie d'extinction. Ces espèces ont généralement des petites populations limitées sur un petit territoire. De récents travaux ont mis en valeur l'importance des espèces communes dans les écosystèmes. Les insectes pollinisateurs dont la contribution à la production alimentaire globale en 2005 a été évaluée à 153 milliards d'euros (Gallai et al. 2009) en sont un exemple : une diminution de leur abondance entraine une des perturbations majeures sur la structure des écosystèmes et des services qu'ils peuvent rendre (Gaston et Fuller 2008).

Le déclin des espèces communes a été démontré pour quelques taxons, notamment les oiseaux dans les zones agricoles (Figure 1). Partout dans le monde, les populations d'abeilles seraient en déclin, surtout dans les pays industrialisés (http://www.inra.fr, 2005).

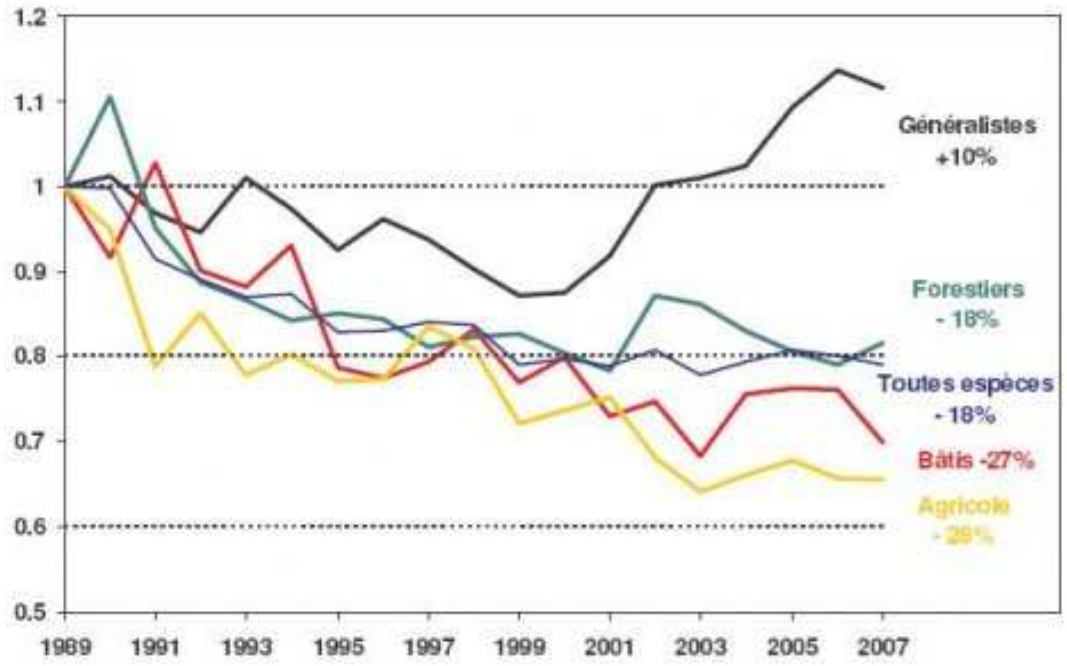

Figure 1 : Les indicateurs de l'abondance des oiseaux communs par habitat de 1989 à 2007. En jaune les espèces de milieux agricoles, vert milieux forestiers, rouge urbains, généralistes en noir, toutes espèces en bleue. (D'après Jiguet F., Programme STOC 2007).

Figure 1*: Changes in the abundance of common bird species by habitat from 1989 to 2007. Species from agriculture land (yellow line), from forest area (green line), urban area (red line), all species (blue line) and generalist species (black line) (From Jiguet F, Programme STOC, 2007).*

Des espaces anthropisés refuges d'une biodiversité commune et patrimoniale

Les espèces communes sont particulièrement présentes dans un environnement familier, y compris les espaces urbains et périurbains. Ceci étant entre autre, la conséquence de l'intensification de l'agriculture qui a poussé des espèces dont les populations ont décliné à trouver refuge dans ces milieux (e.g., les abeilles). Ainsi des espaces anthropisés, comme des ronds points peuvent abriter des espèces rares et patrimoniales (Leather 2009 ; pers. com.) Les espaces verts et les jardins, peuvent apporter une contribution à la protection de la biodiversité (Fuller and Gaston 2009).

Ces espaces sont des atouts importants d'autant plus qu'ils représentent au total une surface importante dans un environnement dominé par le béton et l'agriculture intensive.

Des espaces pourtant mis à mal

Les ceintures vertes autour des villes, autrefois souvent constituées de bocages et de prairies sont de plus en plus grignotées par la construction de lotissements, de zones commerciales ou de parkings. De nombreuses zones tampons, refuges pour la biodiversité coincée entre un désert de cultures intensives et un mur de béton, disparaissent. En Angleterre, les jardins représentent 23% des espaces urbains. Les jardins et les espaces verts (bords de routes, parcs urbains…) pourraient être aménagés de façon optimale pour accueillir la biodiversité. Des études montrent de plus, les bienfaits psychologiques d'une nature de proximité (Kaplan and Talbot 1983 ; Wells 2000 ; Wells and Evans 2003). Malheureusement les jardins comme les espaces verts sont le plus souvent dominés par la monotonie des pelouses rases et l'absence de plantes sauvages (Figure 2). Pire, on lutte contre cette biodiversité en utilisant des herbicides, pesticides…. Selon une étude aux Etats-Unis, la surface allouée à la pelouse, 25 million d'hectares, est plus importante que n'importe quel type de culture. Proportionnellement les propriétaires utilisent 10 fois plus de produits phytosanitaires par hectare que les agriculteurs (Uhl 1998).

Figure 2 : Contraste paysagé saisissant entre deux jardins.

Figure 2*: The contrast in appearance in two garden habitats.*

2.3 L'éducation à l'environnement

2.3.1 L'éducation à l'environnement aujourd'hui

Emergence de l'éducation à l'environnement et ses fonctions

L'éducation à l'environnement a pris une valeur officielle à partir de 1977 date de la conférence de Tbilissi où les Nations Unies pour l'Education et les Organisations Scientifiques et Culturelles (UNESCO) ont fixé les intérêts et les objectifs de l'Education à l'Environnement (EE) à une échelle mondiale (UNESCO 1977).
L'EE prend son importance lors de la convention sur la biodiversité de Rio (1992). L'EE devient un élément ayant « une importance critique pour promouvoir un développement durable et améliorer la capacité des individus à s'attaquer aux problèmes du développement durable, en changeant ses propres attitudes, décisions et pratiques quotidiennes » (Agenda 21 Mondial – Chap. 36). L'EE devrait permettre aux citoyens de s'inscrire dans une démarche active à laquelle le terme « développement durable » est souvent associé. Ses valeurs ont été reprises en 2005 par l'UNESCO avec l'emploi du terme de « Education Relative à l'Environnement » (ERE).

Les vecteurs

L'éducation à l'environnement est encouragée quelle que soit sa forme. L'EE peut être formelle et non formelle. L'éducation formelle est celle située dans un cadre bien défini, en particulier l'école ou les associations. L'éducation non formelle est celle qui est peut être réalisée à tout moment, depuis les activités extrascolaires jusqu'au fait de regarder la télévision.
L'école à une importance primordiale. L'EDD fait partie intégrante de la formation initiale des élèves. Une nouvelles circulaire a d'ailleurs vu le jour en 2007 définissant "l'éducation au développement durable" (Ministère de l'Education Nationale et

l'Enseignement supérieur de Recherche, 2007). L'école a l'avantage de toucher presque tous les enfants ; contrairement aux activités parallèles réalisées dans le cadre d'associations ou de clubs-nature qui ne bénéficient qu'à quelques élèves.

L'apprentissage de l'environnement chez les enfants

En théorie, l'éducation à l'environnement est avant tout basée sur l'expérience de l'individu qui influencera l'apprentissage et le développement de ses attitudes, particulièrement lors de son enfance. Kellert (2002) distingue 3 types d'expérience de la nature pouvant avoir un impact sur l'enfant : 1-l'expérience directe ; 2 l'expérience indirecte ; 3 l'expérience symbolique ou interposée. L'expérience directe implique un contact physique avec un objet naturel (plante, animal…) dans un contexte non formel (promenade, sortie de terrain…), l'expérience indirecte induit un contact mais dans un cadre programmé et restreint (zoo, aquarium, animaux de compagnie) enfin l'expérience symbolique est caractérisée par l'absence totale de contact physique avec le monde naturel. Ce dernier type d'expérience est prépondérant dans la société moderne où la télévision et les ordinateurs occupent une place importante dans la vie des enfants. Ces trois niveaux d'expérience sont liés aux différents modes de développement de l'individu. On distingue alors trois types d'apprentissage : 1-Cognitif ; 2- Affectif ; 3 Evaluatif (Figure 3). L'apprentissage cognitif correspond au développement intellectuel, à la façon de penser et de résoudre des problèmes. L'apprentissage affectif ou maturation affective correspond à l'émergence de l'émotion et de sentiments. Enfin le développement évaluatif est lié à des valeurs, des croyances et à la morale.

L'expérience agit sur ces trois types essentiels de développement à la formation de l'esprit critique de l'individu. Dans ce cadre, il est clairement recommandé que les démarches éducatives fassent participer activement les acteurs (enseignants et élèves) à des expériences concrètes qui peuvent être reliées aux divers actes de la vie quotidienne (Ricard 2003). Ainsi à l'école primaire, l'éducation à la biodiversité doit

inclure un large panel de méthodes d'apprentissage pour les activités de terrain (Lindemann-Matthies et al. 2009).

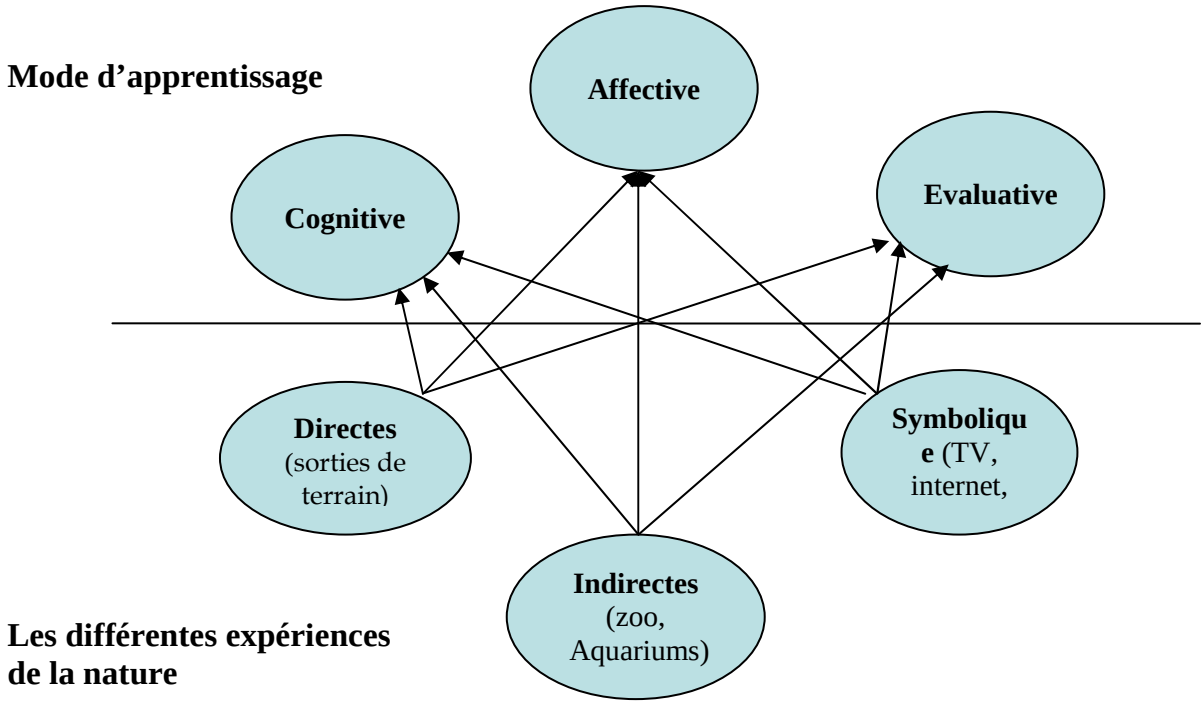

Figure 3 : Relation entre les 3 types d'expériences de la nature et les 3 modes d'apprentissage dans le développement de l'enfance (Source : Kellert 2002).

Figure 3: *Type of nature experience and modes of learning in childhood development (from Kellert 2002).*

2.3.2 L'éducation pour connaitre et protéger la biodiversité

L'éducation pour développer la connaissance de l'ensemble de la biodiversité

Il est largement admis que les personnes font attention à ce qu'elles connaissent (Balmford et al 2002 ; Lindemann-Mathies 2006). Accroître les connaissances du public sur les éléments naturels et les besoins de préserver la biodiversité est donc essentiel (Lindemann-Matthies 2002), de même pour l'allocation de fonds (Wilson and Tisdell 2005). Actuellement, la connaissance de la biodiversité aussi bien chez les

enfants que chez les adultes, apparaît extrêmement pauvre et incohérente (Randler 2008).

Les animaux : un lien entre les enfants et la préservation de l'environnement

L'homme entretien des relations étroites avec les animaux, notamment via la domestication. Cette relation est liée au concept de biophilie (Kellert and Wilson 1993 ; Wilson 1984, 1993), c'est-à-dire notre capacité innée à s'intéresser et aimer le monde vivant. Les enfants développent tout particulièrement des relations avec les animaux. Selon certains psychologues Myers et Saunders, (2002) les liens entre les animaux et les enfants mettent en jeu chez ces derniers des développements à la fois cognitifs, émotionnels et moraux. Ainsi les animaux sont les principales connexions entre les populations humaines et le monde naturel, ils sont l'un des principaux canaux pour promouvoir l'éducation à l'environnement (Myers and Saunders 2002 ; Vining 2003). Par exemple, les enfants peuvent facilement se rendre compte que les animaux dépendent de leur habitat et écosystème, ils seront ainsi plus à même de les protéger.

Les médias dans l'éducation scolaire

L'influence des médias est véhiculée par la télévision et les médias électroniques (internet) qui sont de plus en plus facile d'accès. Dans les classes, il y a encore peu de temps, les médias étaient présents *via* la diffusion de magazines et de quotidiens, disponibles dans la bibliothèque des écoles. Ces magazines pouvaient, par exemple, servir d'outils pour traiter d'un problème de l'actualité. Aujourd'hui l'ordinateur remplace largement le papier dans les classes et il y a souvent une connexion internet disponible. Il est logique que les éducateurs utilisent ce système pour aborder des sujets liés à l'environnement (Figure 4). Par ailleurs, les enseignants ont de plus en plus de difficultés à réaliser des sorties sur le terrain avec leurs élèves ; par manque de temps, de fonds ou de compétence et de souplesse administrative (Lindemann-Matthies et al. 2009). Les médias électroniques compensent partiellement ces difficultés, mais au détriment d'une approche de terrain et d'expérience (Ballouard

2005). Le danger est que l'utilisation des medias en classe reste une approche basée sur des éléments virtuels et distants, le dogme et la propagande s'y installe plus facilement que sur le terrain qui est moins manipulable et qui n'est pas truqué. A l'école, les expériences directes avec la nature sont progressivement entièrement remplacées par des expériences virtuelles (Williams and Handford 1986 ; Chawla 1994). Quelles seront les conséquences de la sur-utilisation des médias sur l'apprentissage, l'esprit critique et le développement des attitudes et des comportements favorables envers l'environnement ?

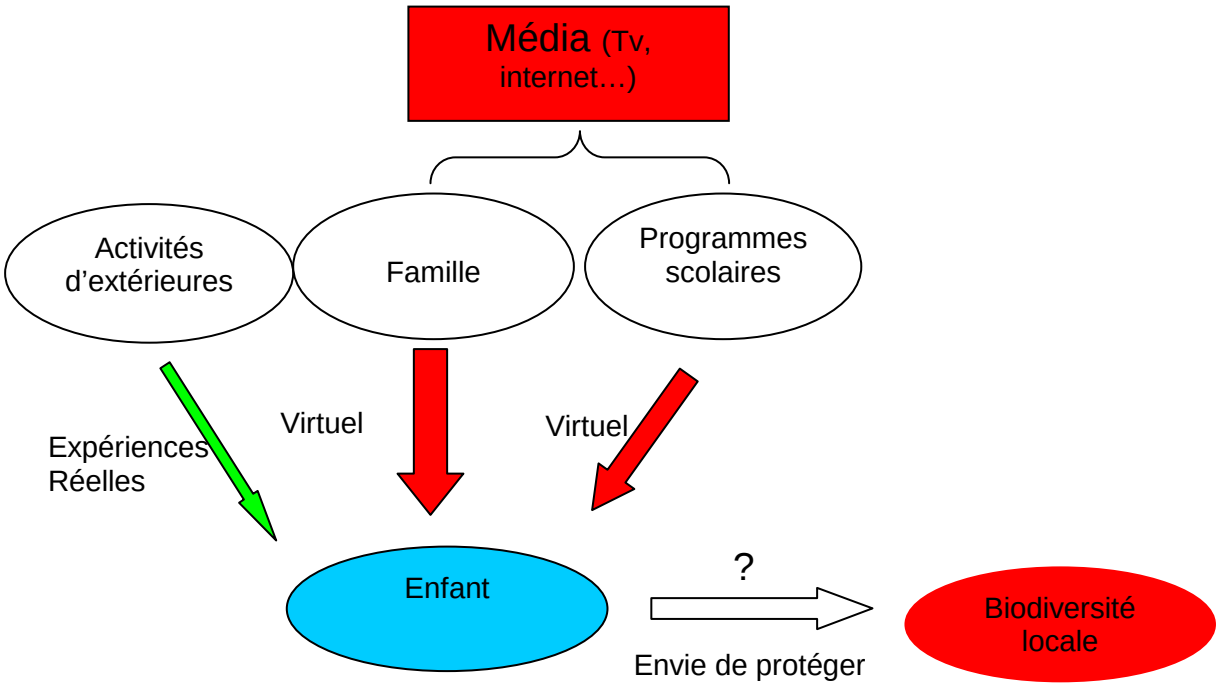

Figure 4 : Place et influence des médias dans l'éducation à la biodiversité des enfants.
***Figure 4**: Position and effect of various media sources in schoolchildren biodiversity education*

2.3.3 La place de l'éducation dans la conservation et son évaluation

L'éducation dans les programmes de conservation

La préservation d'un écosystème ou d'espèces en particulier doit nécessairement prendre en compte les interrelations entre l'homme et la nature. Ces relations peuvent être d'ordre social (des relations humaines s'organisent autour des éléments naturels) ; d'ordre économique (consommation des ressources naturelles, chasse, agriculture…) ; culturelles (traditions) voire cosmogoniques (les éléments naturels en tant que symbole dans l'agencement du monde). Ne pas prendre en compte l'ensemble de ces considérations dans les programmes de conservation est souvent voué à l'échec. Pour exploiter les ressources naturelles durablement il est nécessaire de changer de pratiques et des perceptions de la nature. L'éducation à l'environnement est l'un des seuls outils efficaces à long terme (Browning et al. 2006). L'ensemble des programmes de conservation inclut désormais une forte composante éducative (e.g. le cas de la conservation du gavial du Gange, (cf annexe, Ballouard et al. *In Press*.).

La place des études sur l'éducation à l'environnement dans la biologie de la conservation

Les fondateurs de la société pour la conservation de la biologie « Society for conservation Biology » SCB intègrent en 1987 l'éducation comme un des ses six objectifs (SCB 1987). En 2004, un article de Trombulak et al. (2004) paru dans la revue Conservation Biology, définit précisément les lignes directrices du comité d'éducation pour la « conservation literacy ». L'éducation à l'environnement paraît donc avoir une place très importante, cependant en pratique la situation est différente.

La dichotomie dénoncée entre recherche scientifique et éducation est bien réelle (Brewer 2006). L'enquête de cet auteur montre que sur 553 articles scientifiques édités dans « Conservation Biology », 18 % mentionnaient le mot éducation, 71 étaient des articles ciblés sur l'éducation, soit une moyenne de 4 articles par an. De façon globale, depuis 10 ans, alors que le nombre d'articles incluant le mot éducation augmente de façon significative le nombre d'articles et essais dans le domaine restent très bas (Brewer 2006). L'importance de l'EE dans la pratique quotidienne de la

biologie de la conservation reste donc modeste. Il est toutefois important de souligner un effort grandissant du CNRS et de certains programmes Européens dans ce domaine.

Evaluation des programmes d'éducation

L'éducation à l'environnement se réalise différemment dans de nombreux contextes culturels, sociaux, ou économiques. Par exemple, la sensibilisation du public sera bien différente si l'on parle de loups à des éleveurs ou à des citadins. Le consentement des gens à protéger la biodiversité dépend des valeurs monétaires (médecine, écotourisme) et non monétaires (éthique, esthétique), or ces valeurs varient en fonction des cultures (Trombulak et al. 2004 ; Lindemann-Matthies et al. 2009). De nombreux facteurs doivent être pris en compte et nécessitent souvent au préalable un état des lieux sur les attitudes de base.

Mais il n'existe pas de méthode standard. L'évaluation des programmes de conservation est à la fois nécessaire et dans un état encore balbutiant. Une conséquence est qu'il est difficile de savoir quelles sont les techniques qui favorisent le développement des attitudes et des comportements les mieux associés à la préservation de la biodiversité. Quels espèces, écosystèmes, etc. faut-il cibler ? Les ours polaires qui attirent les élèves mais ne permettent pas d'actions concrètes sont ils les modèles les plus intéressants ? Que dire des araignées mal aimées mais si proches des enfants et pour lesquelles tout reste à faire ou presque ? Quelles sont les espèces les plus utiles dans une démarche éducative basée sur l'expérience de terrain ?

2.4 L'éducation et les serpents

2.4.1 Un animal mal aimé, symbole d'une biodiversité négligée

S'il y a bien un animal où des progrès sont à faire en matière de connaissances et d'attitudes du public, c'est le serpent. Les serpents sont considérés comme les animaux les plus mal aimés, ils inspirent la peur et le dégout. Ils sont parfois la cause de phobies (ophiophobia). Dans les pays où les serpents venimeux sont nombreux et l'accès aux soins difficiles la crainte est largement justifiée, mais dans les pays occidentaux où les risques (chances ?) de rencontrer des serpents sont rares, la peur est irrationnelle, issue d'un imaginaire collectif. Dans la culture occidentale récente légendes et mythes à leur sujet sont souvent délirants et sans fondements (e.g., « les serpents tètent les vaches, voire les femmes », France, Mexique). Ce genre de perceptions est issu d'une large méconnaissance envers les serpents. Le plus souvent, l'image du serpent est celle d'un animal dangereux et spectaculaire, venimeux et gigantesque. Les médias diffusent largement ces images avec des films à sensations (e.g., « Les serpents dans l'avion », « Anaconda »…), et à propos d'évasions d'animaux exotiques cobras et pythons.

En France sur 11 espèces présentes, 2 sont venimeuses et leurs aires de répartition ne se recoupent généralement pas. Les espèces que nous rencontrons le plus souvent dans la nature sont donc des couleuvres. Dans de nombreux discours de gens interrogés s'opère la distinction entre les « serpents » et les « couleuvres ». Les couleuvres ne seraient donc pas des serpents parce qu'elles ne sont pas venimeuses. Ceci témoigne à la fois de l'association basique des serpents avec l'image d'une espèce dangereuse et d'un manque accru de connaissances sur les serpents. Les serpents ne sont pas les seules espèces touchées par cette méconnaissance, plus largement toute la biodiversité qui nous entoure (insectes, micromammifères).

Le serpent est un animal non désirable. Il est le symbole d'une nature sauvage que l'on ne contrôle pas, dont on a peur, tout comme est perçu un roncier, une friche, un muret délaissé aux lierres… Ces espaces sont pourtant les deniers refuges d'une biodiversité urbaine ou périurbaine (Figure 5). D'ailleurs, la présence de l'animal est souvent associée à ce genre d'habitat. Quoi de plus logique donc, que de faire disparaître les ronciers, aubépines et hautes herbes pour se débarrasser des serpents ?

Figure 5 : Photo d'une friche en zone périurbaine. Cet espace abrite de nombreuses espèces de plantes et insectes et offrent de nombreux abris aux serpents.

Figure 5: *Picture of field habitat, a suitable habitat for snakes where numerous plant and animal species occur.*

2.4.2 Eduquer pour préserver des populations en déclin

Comme beaucoup d'organismes, les serpents font aujourd'hui face à un déclin général (chap 4.3.1). En France, il est lié principalement à la disparition et à la dégradation des habitats favorables, au développement de l'agriculture intensive, de l'urbanisation, à l'utilisation de pesticides….Alors même que les espèces sont toutes officiellement protégées (liste rouge des espèces menacées, UICN France, 2010) les serpents continuent de se faire tuer délibérément dans les jardins, sur les routes… (données non publiées, Ashley et al. 2007). L'attitude générale du public envers les serpents est loin de leur être favorable, la rencontre entre l'homme et le serpent finit le plus souvent par un coup de bêche. Ce genre de comportement peut être partiellement responsable de leur disparition. Pour enrayer ce déclin nous verrons que des solutions simples et peu coûteuses existent (Chap. 4.3.2). Mais elles ne

peuvent être appliquées sans l'assentiment des populations et des décideurs. L'éducation, qui vise à améliorer la connaissance des serpents est donc fondamentale. Les enfants doivent être particulièrement ciblés car leurs perceptions et idées préconçues ne sont pas encore figées comme chez la plupart des adultes.

2.4.3 Eduquer sur les serpents pour englober toute la biodiversité

Pour engendrer des attitudes et des actions favorables à la biodiversité, il est logique de s'intéresser aux organismes les moins aimés (Kellert 1993, 1996). Inversement se focaliser sur des espèces charismatiques ou déjà attractives aux yeux du public ne permet pas de réaliser de progrès importants. Autrement dit, plutôt que de tourner en cercles en admirant encore et toujours les oiseaux et les grands félins, il est plus efficace d'aller de l'avant et de regarder de plus près les organismes trop souvent détestés à tort, et les serpents font donc partie des meilleurs candidats pour cela (Seshadri 1984 ; Prokop et al. 2009). C'est précisément pour ce genre de raison que les serpents peuvent être de bons indicateurs pour évaluer la pertinence d'une action d'éducation ; un succès avec eux démontrerait *a fortiori* qu'il est possible de faire la même chose avec de très nombreuses autres espèces. Par ailleurs, plusieurs espèces de serpents sont robustes et faciles à manipuler sans être trop stressées ni risque d'être blessées. Les micromammifères ou les oiseaux sont beaucoup plus compliqués à mettre entre les mains des enfants sans entrainer de la casse. Les serpents sont donc des organismes appropriés pour mettre en place des actions éducatives basées sur l'expérience.

3 Méthodologie

3.1 Mise en place et diffusion du questionnaire sur la biodiversité et les serpents

3.1.1 Elaboration du questionnaire

Choix du type de questionnaire

Pour sonder la perception des enfants, envers la faune (e.g. animaux locaux *vs* exotiques, serpents…), différentes méthodes sont disponibles depuis les entretiens collectifs, individuels, vers les questionnaires écrits, questions à choix multiples (QCM), etc. Les entrevues semi-ouvertes (questions semi-dirigées) ont l'avantage par exemple de connaître les causes sous-jacentes des perceptions des interlocuteurs mais l'inconvénient d'être limitées en nombre d'interlocuteurs compte-tenu d'un temps d'analyse important. De plus, les interférences interindividuelles, intéressantes en tant que telles, posent aussi des problèmes analytiques et statistiques. Les questionnaires individuels écrits donnent un aperçu plus contraint des représentations, mais ils ont l'avantage de pouvoir enquêter un grand nombre de personnes, ce qui permet d'en retirer des tendances à travers des analyses statistiques, ce qui est un avantage considérable dans les processus d'évaluation et l'approche comparative. Nous avons donc opté pour la seconde option qui a consisté à distribuer à un nombre important d'enfants, un questionnaire écrit. Toutefois, l'interprétation des questionnaires soumis notamment à des enfants doit être réalisée en tenant compte de différents aspects méthodologiques (Groves et al. 2009).

Elaboration

L'élaboration du questionnaire s'est faite en deux principales étapes (Figure 1).
1- En 2005, en concertation avec Michel Place (Instituteur et docteur en psychologie de l'enfance), deux méthodes ont été utilisées, à la fois des questions écrites individuelles (e.g. question écrite semi-ouverte : « liste 10 animaux qu'il faut protéger

en priorité ») et des questions orales collectives, ouvertes (« donnez moi tous les mots que vous évoque cette image ») (Ballouard 2005). Déjà des tendances nettes (préférence envers les animaux charismatiques et de compagnies) ont été mises en évidence, mais l'analyse était limitée à ces deux classes.

2- En début de thèse 2007, l'objectif était entre autre de vérifier cette tendance et d'étendre nos objectifs à une échelle internationale. Pour cela, il a fallu construire un questionnaire écrit à la fois pertinent et le plus concis possible.

L'élaboration de ce questionnaire s'est faite en deux sous-étapes. Dans un premier temps différentes questions ont été testées de façon indépendante. Par exemple, certains termes ont été remplacés pour une même question (e.g. « Cite des espèces qui doivent être protégées » vs « cite les espèces que tu veux protéger »). De façon empirique, les questions inutiles ont été enlevées (par exemple, il n'y a pas de différence entre le fait de demander cinq espèces à protéger ou dix), les plus pertinentes ou celles qui engendraient le moins de biais ont été retenues (« cite les espèces qui doivent être protégées en priorité » était la question la plus neutre). Pour plus de précisions sur ces résultats, des analyses sont présentées dans le chap 4.1.1 .

Le questionnaire global comprenait non-seulement des questions ouvertes pour lesquelles les enfants répondent librement, mais aussi des questions fermées et très cadrées. Par exemple, les questions ouvertes sont obtenues en demandant une liste d'animaux que les enfants souhaitent protéger ; puis en expliquant pourquoi. Les questions fermées correspondent par exemple à des planches d'images que les enfants doivent identifier, ils n'ont pas d'autre choix. Le questionnaire a donc été construit sur la base de deux approches complémentaires, l'une spontanée (espèces citées librement) l'autre contrainte (identification d'animaux à partir d'image données aux enfants). Pour cette deuxième approche, une planche représentant 20 animaux a été réalisée. Elle représentait en nombre égal des photos d'animaux exotiques et d'animaux locaux. Parmi les espèces exotiques, des espèces charismatiques (panda, ours polaire) mais aussi non charismatiques (pangolin, caïman) ont été utilisées. Les espèces locales ont été retenues sur la base de leur visibilité, c'est-à-dire ces espèces devaient être toutes susceptibles d'être vues

régulièrement dans la nature par un enfant de la région (par exemple : les merles, les scutigères).
Après différents essais et erreurs (question mal formulée), non-présentés ici par soucis de concision, un questionnaire standard a été élaboré.

Questionnaire final

Le questionnaire final est composé de 21 types de question à la fois semi-ouvertes (11 questions) et fermées (43 questions) (réponse aux choix) (total 54 questions) (cf Annexe). Le questionnaire contient d'autres questions relatives aux informations démographiques de base (sexe, âge…) et se compose de deux parties. 1) les animaux en général (21 questions), 2) les serpents (33 questions). Dans le cadre de cette thèse, un certain nombre de questions n'ont pas encore fait l'objet d'analyses. Chaque enseignant s'est également vu remettre un questionnaire (par exemple, pour mieux connaître les activités liées à la découverte de la biodiversité réalisées en classes).

3.1.2 Diffusion du questionnaire

Consignes du questionnaire

Les questionnaires ont été remplis par les enfants individuellement pendant le temps de présence en classe (Figure 1). Une durée de 20 à 45 minutes est nécessaire selon l'âge des enfants. De nombreuses sources de biais pouvaient affecter les réponses des enfants (chap. 4.1.1). Celles-ci pouvaient être à la fois dues au contexte au cours de l'exercice, ainsi qu'à des facteurs géographiques, culturels, etc.
Tout d'abord, l'ordre des questions est important, par exemple la présentation de la planche d'animaux avant la question « cite les animaux qui doivent être protégés » aurait fortement biaisé cette dernière et annulé au moins en partie l'effet de spontanéité. Aussi il était important d'introduire dans un ordre précis le questionnaire. Ayant personnellement fait une grande partie des enquêtes en France, il aurait été regrettable de me présenter en tant qu'étudiant du laboratoire

d'herpétologie du CEBC, aussi j'ai soigneusement évité de dire que j'étudiais aussi les serpents. Là encore il y aurait eu de fortes chances pour que le serpent soit artificiellement bien placé dans la liste des animaux à protéger. Pour beaucoup d'enfants, les insectes ne sont pas des animaux, l'introduction au questionnaire devait donc resituer la place des différents organismes au sein de la biodiversité et des animaux (chap 4.1.1). Il était également important de rappeler aux enfants que ce questionnaire n'était pas un examen et qu'aucune note ne serait donnée. Dans le cas où les questionnaires ont été donnés aux élèves par les enseignants eux mêmes, ces différentes précautions et consignes leur ont été formulées sous forme de directives écrites (cf annexe).

Figure 1 : Les écoliers remplissent les questionnaires pendant un temps de classe, 20 à 45 minutes sont nécessaires selon l'âge des enfants.

Figure 1*: Questionnaires were filled in by schoolchildren during 20 to 45 minutes in class.*

Interlocuteurs

Parce qu'ils sont à la fois à un âge où se construisent les attitudes et où ils sont en mesure d'écrire, l'enquête s'est principalement focalisée sur les enfants de primaire de cycle 3 (CE2-CM1-CM2). En adaptant le questionnaire, j'ai néanmoins étendu

l'enquête à quelques classes de CP-CE1, deux classes de 6ème, ainsi qu'à des étudiants à l'université en filière de biologie (Bac +1 à Bac +5). Dans ce cadre, il était notamment très intéressant de comparer la connaissance des espèces locales entre les étudiants et les enfants. De façon surprenante, les écarts ont été modestes, mais ces résultats ne sont pas présentés dans la thèse par concision. La grande part des enfants interviewés est issue de la région Poitou Charente dans le sud des Deux-Sèvres (79). Les écoles ont été choisies au hasard à la fois dans un milieu urbain (centre de Niort) et un milieu plutôt rural (autour de Chizé). L'intérêt de cet échantillonnage se basait sur l'hypothèse que les enfants issus d'un milieu rural passent plus de temps au contact de la nature que ceux de milieux urbains. Dans une moindre mesure l'enquête en France s'est étendue en Bretagne (région Plouay, milieu rural, 3 classes), Landes (Gradignan, 2 classes) et la ville de Tours (4 classes). Au total la partie française de l'étude a impliqué 12 écoles et 683 écoliers (31 classes, 12 écoles).

Diffusion internationale

Grâce à un réseau de collaborateurs notamment herpétologues, j'ai pu donner une dimension internationale à cette enquête. Comparer les résultats des enquêtes était d'autant plus intéressant que les pays concernés offraient des contrastes géographique, culturel, et social. Les questionnaires ont ainsi été diffusés dans 10 pays de 3 continents différents (Afrique, Asie et Europe) (Tableau 1). Le contraste entre ces pays repose essentiellement sur leur indice de développement, des plus élevés (France) au plus bas (Népal) en passant par différents gradients. Ce gradient s'accompagne en général d'un certain niveau d'éducation et d'accès à la modernité. Dans le cadre entre autre, de l'objectif qui consiste à tester l'influence des médias (véhiculé principalement par la télévision) sur la perception de la biodiversité des enfants, cette dimension comparative était un atout. Néanmoins que ce soit à Katmandou (Népal) ou à Tours (France), la télévision est au centre des activités sociales. Il était donc important de pouvoir échantillonner les classes à la fois dans un milieu urbain et rural, ce qui a été fait dans cinq des dix pays enquêtés (Tableau 1). Au total 2761 écoliers dont 1342 filles et 1419 garçons ont participé à cette étude, la

plupart d'entre eux âgé de 10 à 12 ans. Pour l'étude présentée dans l'article 1 (page 61), 2121 élèves agées de 10 à 12 ans ont été sélectionnés. L'article 2 (Page 97), présente une étude basé sur 250 élèves français. L'ensemble des 2570 élèves a été pris en compte dans l'étude présenté dans l'article 3 (page 127).

Tableau 1 : Nombre de classes et nombre d'élèves interviewés par pays en fonction de la situation géographique (urbain et rural) et de la classe d'âge (6-9 ans), (10-12 ans), (12-15 ans) ainsi que le nom des enquêteurs : Jean-Marie Ballouard (JMB), Rastko Ajtic (RA), Halpern Balint (HB), José Brito (JC), Jelka Crnobrnja-Isailovic (JCI), El Hassan ElMouden (HE), Mehmed Erdogan (ME), Monica Feriche (MF), Juan Manuel Pleguezuelos (JMP), Pavol Prokov (PP), Antonio Sánchez (AS), Xavier Santos (XS), Tahar Slimani (TS), Bogoljub Sterijovski (BS), Lijiljana Tomovic (LT), Muhammet Uşak (MU), Marco Zuffi (MZ).

Table 1: *Number of classes and schoolchildren interviewed in each country according to the geographic situation, age and the interviewers.*

Pays	Situation géographique	Nombre total de classe	6-9 ans	10-12 ans	12-15 ans	Nombre total d'élèves	Enquêteurs
France	Rural	22	259	193	0	452	JMB
	Urbain	9	81	113	0	194	JMB; ENS
Espagne	Rural	8	84	63	45	192	JMP; MF; AS
	Urbain	15	25	290	9	324	JMP; MF; AS
Serbie	Rural	15	0	79	40	121	RA; LT ; BS
	Urbain	12	0	112	37	150	RA; LT; JCI ; BS
Népal	Rural	3	2	35	37	74	JMB
	Urbain	5	10	59	12	81	JMB ; EHE; TS
Maroc	Rural	3	0	69	23	92	JMB; EHE; TS
	Urbain	4	9	136	13	158	JMB; ENS; EHE; TS
Slovaquie	Rural	8	54	108	0	162	PP
	Urbain	0	0	0	0	0	
Italie	Rural	0	0	0	0	0	
	Urbain	6	58	39	0	97	MZ
Turquie	Rural	0	0	0	0	0	
	Urbain	10	0	185	143	328	MU; ME
Portugal	Rural	3	17	21	23	61	JB
	Urbain	0	0	0	0	0	JB
Hongrie	Rural	12	63	143	72	280	HB
	Urbain	0	0	0	0	0	
TOTAL		135	662	1645	454	2761	

3.2 Du suivi de population des serpents au projet « Peuple des broussailles »

3.2.1 Suivi de population et aménagements

Les espèces étudiées dans la réserve biologique de Chizé

Depuis 1988, quatre populations de serpents sont étudiées dans la réserve Biologique Intégrale de Chizé (RBI) : la couleuvre verte et jaune (*Coluber [Hierophis] viridiflavus, Cv*), la couleuvre d'Esculape (*Elaphe longissima [Zamenis longissimus], El*) et la couleuvre à collier (*Natrix natrix, Nn*) et un vipéridé (*Vipera aspis, Va*) (Figure 2). Ces espèces, de taille moyenne (50-70 cm pour *Va* à 120-150 cm pour *Cv*), sont largement représentées en France. Les deux premières espèces ont une aire de répartition sensiblement similaire qui s'étend du Nord-Ouest de la France jusqu'au Sud, ce sont les plus abondantes sur le site. La couleuvre à collier est présente sur tout le territoire et la vipère aspic sur la partie trois-quarts Sud.

Ces trois couleuvres sont ovipares (Naulleau 1984). Les accouplements débutent dès le mois de Mai après une hibernation de 4 à 6 mois selon les conditions météorologiques (Novembre-Avril). Fin juin, commence la période où les femelles vont pondre. Jusqu'à Juillet, les serpents adultes sont particulièrement actifs, les mâles pour trouver des partenaires et les femelles pour trouver des sites de pontes (Bonnet et al. 1999). Les serpents peuvent alors effectuer de grands déplacements et sont vulnérables vis-à-vis des prédateurs et des écrasements sur les routes. Après une période d'incubation des œufs de 6 à 8 semaines, les nouveau-nés émergent fin Aout-début Septembre. Les vipères aspic sont vivipares et mettent bas en général au moi de Septembre. Ces quatre espèces possèdent un régime alimentaire diversifié, composé en grande partie de micromammifères mais aussi d'oiseaux, lézards et amphibiens (Naulleau 1984, Lelièvre 2010).

Figure 2 : Les serpents de la forêt de Chizé (Couleuvre à Collier, Couleuvre Verte et jaune, Vipère aspic et couleuvre d'esculape.

Figure 2: *The snake species of the Chizé forest (*Natrix natrix, Hierophis viridiflavus, Vipera aspis and Elaphe longissima*).*

Les sites

La RBI (2579 ha), interdite au public, se situe dans la forêt domaniale de Chizé (4885 ha), dans le département des Deux-Sèvres (79), au sud de la ville de Niort. Le site est principalement géré par l'Office National des Forêts (ONF) et l'Office National de la Chasse et de la Faune Sauvage (ONCFS). Ce massif représentatif de l'habitat « hêtraie calcicole sud-occidentale » est influencé par un climat océanique à tendance méditerranéenne (Figure 3).

Sur la base de cette expérience réalisée dans la RBI, depuis 2006, un suivi a été également mené sur le site de l'Arche de la Nature près du Mans (Sarthe) (72). Ce site présente une toute autre configuration car situé en pleine zone périurbaine entre les

villes du Mans, Changé et Yvré l'Evêque (Figure 3). Il est constitué de 210 ha de boisement (pinède essentiellement) et de 270 ha de prairies, landes bocages et soumis à un climat océanique dégradé. Chaque année, ce site accueille plus de 500 000 visiteurs. Trois espèces précédemment décrites (*El, Nn, Va*) sont présentes sur le site. Cependant *Va* est l'espèce la plus largement répandue, et une autre espèce de colubridé est bien représentée, la coronelle lisse (*Coronella austriaca*).

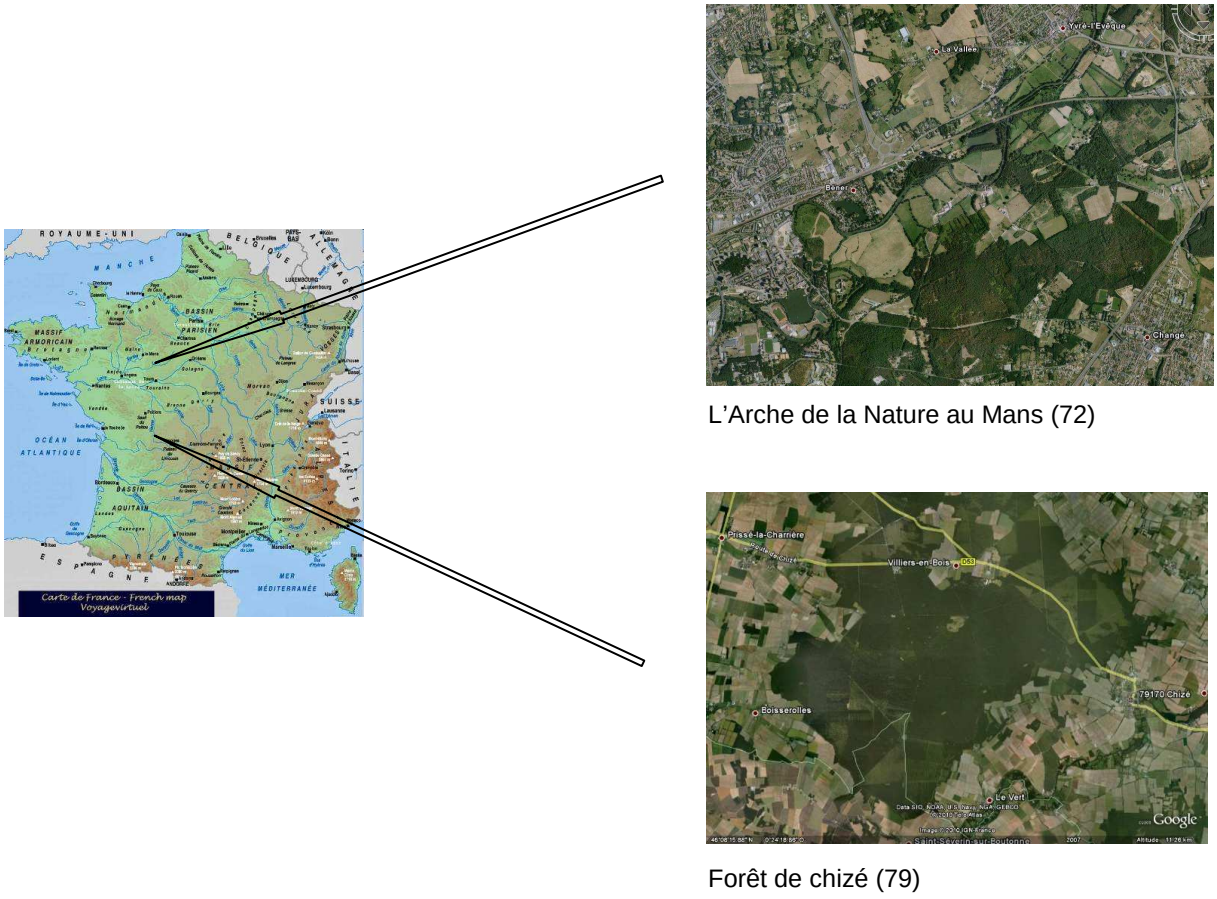

Figure 3 : Localisation et photo aérienne du site de l'Arche de la Nature en zone périurbaine du Mans et du site de la fôrêt de Chizé (Réserve Biologique Intégrale, RBI).

Figure 3: *Location of the l'Arche de la Nature in the suburb of Le Mans and the RBI (« Complet biological reserve ») in the forest of Chizé.*

Aménagements

Les serpents sont des espèces peu visibles. Pour augmenter les chances de les capturer un réseau de près de 800 plaques de fibrociment a été installé dans la RBI depuis 1988 (Figure 4). Ces plaques sont attractives pour les serpents parce qu'ils peuvent avoir accès à des températures optimales pour thermoréguler tout en étant protégés des prédateurs (comme la buse ou circaète Jean le Blanc). Ces plaques servent également d'abris à de nombreux micromammifères. Les plaques sont régulièrement soulevées pendant toute la période d'activité d'Avril à Octobre. Des sites de pontes artificiels ont également été installés (trois en RBI en 2002 et un à l'Arche de la nature en 2007) (Figure 5). Ceux-ci sont composés d'une large couche de terre végétale (1m-2m) avec différents supports (soit de pierres, rondins…). Une bâche peut recouvrir ces sites de pontes et permettre la colonisation des micromammifères créant des galeries qui seront empruntées par les serpents.

Figure 4 : Plaques de fibrociment et capture d'une jeune couleuvre verte et jaune dans la RBI (79); Au total près de 800 sont disposées dans la RBI et une centaine à l'Arche de la Nature.

Figure 4*: Slabs and capture of a juvenile of Coluber virodiflavus in the RBI.*

a) Site de ponte dans la RBI (79)

b) Site de ponte à l'Arche de la Nature (79)

Figure 5 : Exemple de sites de pontes artificiels dans la RBI et l'Arche de la nature.
Figure 5*: Example of artificial nesting sites in the RBI and l'Arche de la Nature*

Depuis 1988, ces aménagements et prospections ont permis la capture de plus de 7000 serpents dont près de la moitié sont des recaptures.

Sur le site de l'Arche de la Nature, préalablement à la mise en place du réseau de plaques, les gestionnaires ont favorisé par des tailles en zones fermées (sous bois) le développement d'une strate buissonnante (ronciers, ajoncs…), (Figure 7). L'effet de ces aménagements a été suivi par la mise en place d'un protocole expérimental (2007). Certaines zones ont été modifiées (supposément favorables) par des coupes alors que d'autres non (supposément défavorables), d'autres zones où la végétation avait été modifiée (supposément favorables) ont été laissées à l'abandon, des zones préalablement non modifiées (supposées défavorables) ont quant à elles été modifiées. Chacun de ces quatre cas de figure a été réalisé dans trois sites avec trois réplicas. Chacune des zones a pu être suivie grâce aux plaques disposées.

Figure 6 : Exemples de zone où les arbres à croissances rapides (Aulnes) ont été abattus laissant place à une végétation buissonnante et ouverte. Deux gardes-nature, G. Provost & JL Lassay, fortement impliqués dans le projet.

Figure 6: Area where trees were cut favouring open vegetation (shrubs). Two rangers, *G. Provost & JL. Lassay*, were deeply involved in this project.

Protocole d'étude

Les serpents après avoir été capturés sont mesurés, pesés…, le statut de l'individu est identifié avec précisions : sexe, maturité sexuelle, état de la mue, présence de proies, d'œufs… Chaque serpent est marqué individuellement par des brûlures superficielles de rangées d'écailles ventrales en suivant un code individuel. Cette méthode, bénigne pour le serpent, permet un marquage pérenne. Les rangées d'écailles sont choisies selon une codification particulière qui permet le marquage d'un très grand nombre d'individu (Figure 7). Cette technique communément utilisée permet entre autre d'estimer des paramètres démographiques (taille des populations, survie…), de mieux connaître les territoires vitaux et de collecter de nombreuses informations sur les traits d'histoire de vies (taux de croissance…).

Depuis 1994, les serpents retrouvés écrasés sur les routes sont également collectés ou identifiés par un réseau de collecteur qui s'est amplifié au cours des années. Ce suivi permet entre autre de pouvoir connaitre l'évolution des populations de serpents : le nombre de serpents trouvés morts est proportionnel à celui de ceux qui sont vivants aux alentours.

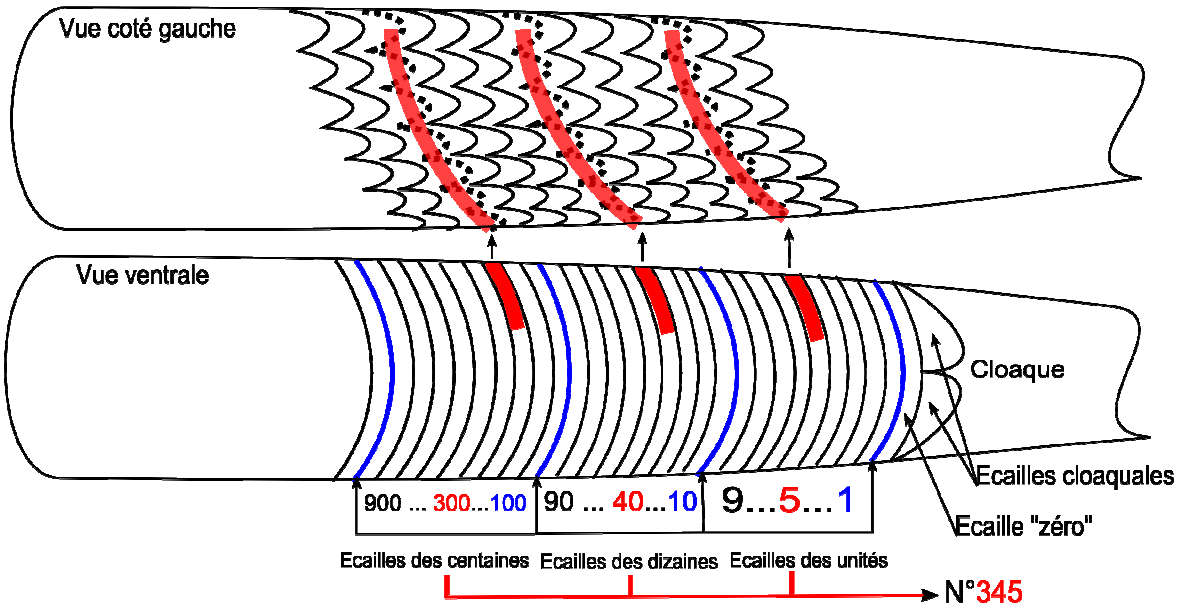

Figure 7 : Système de marquage utilisé pour le suivi des populations dans la RBI et l'Arche de la Nature, l'individu représenté ici est le 345.

***Figure 7**: Marking code for snake population monitoring; example of individual 345.*

3.2.2 Le projet pédagogique « Peuple des broussailles »

Le projet et la sortie de terrain

Le suivi de population de serpents, outre l'intérêt scientifique, présente un intérêt pédagogique évident. Il donne notamment l'opportunité de pouvoir présenter des serpents de nos contrées dans leur milieu naturel, ce qui est aujourd'hui une approche quasi inexistante ailleurs. De plus, le suivi scientifique permet de donner une toute autre dimension à l'activité de pédagogie. Grâce à cette approche, les enfants ne basent pas seulement leurs perceptions sur des discours ou des écrits mais sur leurs propres expériences avec ces animaux. Les individus capturés et re-capturés permettent d'obtenir des informations scientifiques qui sont à la base de ce qui sera expliqué aux enfants. Cette démarche de terrain et de manipulations s'oppose aux approches livresques ou purement contemplatives. Ces expériences passent par la rencontre avec l'animal dans son milieu, son identification (espèces, sexe, marquage…) et repose largement sur le contact physique avec l'animal, contact

rendu nécessaire par les mesures biométriques, le marquage, etc. Il ne s'agit pas d'une parodie d'étude, mais bel et bien d'une immersion dans la recherche en écologie ou tout au moins au suivi de populations. En collaboration avec l'ONF le site « Peuple des broussailles » a vu le jour en 2006 dans le domaine public de la forêt domaniale de Chizé à deux pas de la ville qui porte le même nom (Figure 8). De la même manière qu'en RBI sur environ 60 hectares, un réseau de 160 plaques (en fibrociment non amiantée) y a été installé à la fois dans des zone ouvertes et fermées.

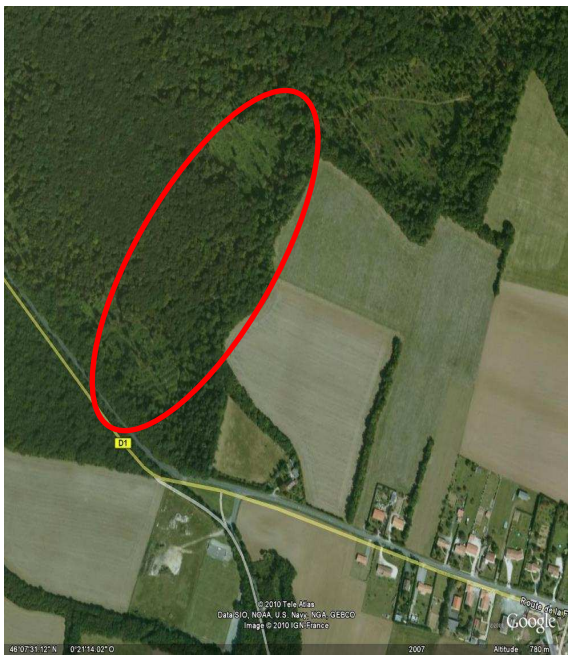

Figure 8 : Localisation du site « Peuple des broussailles » en limite de la forêt domaniale près de la ville de Chizé (79), 160 plaques ont été installées en zone ouverte (régénération, lisière) et fermés.

***Figure 8**: Location of the "Life in the Shrubs" project in the forest of Chizé (79). A network of 160 slabs has been deployed, mostly in open area.*

Depuis 2007, 11 écoles de Niort et des alentours de la Forêt de Chizé ont participé au projet. Au total 30 classes, soit près de 600 enfants majoritairement de cycle 3 (CE2 à CM2) sont venues pendant une journée découvrir et capturer les serpents dans leur milieu naturel *via* les activités réalisées autour du suivi de population des serpents. Sur le site de l'Arche de la nature, trois classes d'une école de la zone de Le Mans ont également participé à cette activité en 2009. Préalablement à la sortie, chaque classe a

décoré une plaque que les enfants ont installée pendant leur sortie donnant ainsi une dimension artistique et une aide pratique technique au projet (Figure 9).

Figure 9 : Plaques décorées par les enfants. Chaque classe installe sa plaque en fin de sortie.

Figure 9*: Decorated slabs by the schoolchildren. Each class set its slabs at the end of the field trip*.

Le matin était consacré à la capture des serpents sous les plaques. Chaque enfant a été invité à soulever au moins une fois une plaque à l'aide d'un encadrant (moi-même ou un de mes stagiaires). La sécurité étant de rigueur, notamment parce que les vipères sont présentes, des gants épais ont été distribués avant de soulever les plaques. Sur l'ensemble des sorties, une seule vipère a été trouvée, la majorité des serpents étant des couleuvres verte et jaune et d'Esculape sur le site du « peuple des broussailles ». Pendant cette « chasse » de nombreux animaux ont été également observés, surtout des araignées (pardoses, Pisaures…) et des insectes qui sont aussi très faciles à montrer aux enfants. Aucune espèce délicate, fragile et compliquée à capturer (oiseaux, papillons…) et à manipuler n'a été utilisée ; ceci afin d'éviter de les brutaliser. A chaque sortie au moins un serpent a été capturé, avec un maximum de

dix. En cas de mauvaises conditions, des serpents préalablement capturés dans la RBI avaient été mis de côté pour compléter la récolte de terrain.

L'après midi était consacré à l'observation attentive des serpents capturés, sous forme de jeux, de manipulations et de mesures nécessaires aux suivis de populations. Pour finir les serpents ont été marqués et baptisés par les élèves, puis relâchés à leur site exact de capture (Figure 10).

Figure 10 : Les serpents capturés sont identifiés, manipulés et mesurés avec les enfants.

Figure 10*: Snake are identified, manipulated and measured with the schoolchildren.*

Evaluation

L'évaluation de l'impact de la sortie a été faite grâce à des questionnaires spécifiques (chap. 3.1.1). Au moins deux mois précédent la sortie, la partie « serpents » du questionnaire général a été complétée dans les classes. Ce questionnaire présente des questions semi-ouvertes et fermées relatives à leur attitude envers les serpents, leur désir pour les protéger, leur connaissances (nombre d'espèces connues…), leurs préconceptions ou idées générales (gluant, méchants.. .) et enfin leur comportement

envisagé dans le cas de la rencontre avec un serpent. Un questionnaire identique a ensuite été rempli par les enfants environ deux semaines après la sortie. Cependant, des questions concernant les activités de la sortie ont été rajoutées à ce second questionnaire. Il s'agit d'un questionnaire de satisfaction, notamment pour évaluer les éléments préférés de la sortie. Des questionnaires contrôles ont également été remplis par les élèves de trois classes n'ayant pas participé à l'activité (Chap 3.1.1).

4 Résultats - discussion

4.1 Etat des lieux de la connaissance des enfants de la biodiversité et de leur désir de la protéger

4.1.1 Résumé du chapitre

Pour répondre au premier objectif de cette thèse il était nécessaire de se doter d'un outil méthodologique pertinent et efficace. Pour cela le questionnaire, un outil largement utilisé en éducation à l'environnement, a été évalué (article 1). A notre connaissance, notre étude est la première à tester de façon assez complète le questionnaire utilisé alors que de nombreux facteurs (influence de l'interviewer, contexte, formulation des questions….) peuvent affecter les réponses des enfants. Certains facteurs peuvent être contrôlés (taille des échantillons par exemple) alors que d'autres le sont moins (influence de la spontanéité ou de l'affectif notamment). Pour tester la qualité des réponses aux questions, par exemple pour examiner leur niveau de compréhension des questions posées, plusieurs formulations ont été proposées sur le même sujet. Nous avons notamment centré notre investigation autour d'une question posée à un nombre élevé d'enfants de 7 à 12 ans issus de 9 pays différents. Cette question consistait à demander aux enfants de lister de façon spontanée cinq animaux qui doivent être protégés en priorité. De subtils changements dans les termes employés dans les questions ont engendré des réponses différentes, ce qui montre la finesse des enfants dans leur réponse. D'une façon générale, la précision des réponses des enfants à cette question a été très forte ; très peu de réponses illogiques ont été enregistrées. Ce qui a aussi montré que les enfants sont largement au courant des problèmes généraux qui pèsent sur la conservation de la biodiversité. Les résultats ont également montré qu'un échantillon d'environ 50 enfants suffisait à obtenir une tendance relativement stable dans la moyenne des réponses, ce qui a permis de dégager des influences géographiques et/ou culturelles. De façon intéressante, l'affectivité développée pour certains animaux (lapins…) a une forte influence sur les réponses. Outre des résultats purement méthodologiques, nos

résultats suggèrent que dans tous les cas, l'affectivité est un élément clé pour toutes les réponses. Dans un contexte qui évolue sans cesse (accès aux technologies, présence des médias) il est important d'utiliser des questionnaires standardisés de façon à évaluer par exemple, l'impact de programmes d'éducation ou pour réaliser des études comparatives.

Grâce à ce questionnaire, il été possible d'évaluer en France, l'influence des médias sur la connaissance des enfants sur les animaux et sur leur désir de les protéger (article 2). Pour cela nous avons, dans un premier temps, sondé, 1- quels sont les animaux que les enfants veulent spontanément protéger, 2- quels sont les animaux les plus fréquemment présentés sur internet comme devant être protégés. Les résultats montrent que tout comme les médias, les enfants sont très limités dans leur choix des espèces protégées ; en gros, les mêmes espèces charismatiques et domestiques sont les mieux représentées dans l'esprit des enfants et dans les médias. Ces résultats ont été complétés par une approche plus contrôlée qui a consisté à la fois à demander aux enfants de nommer 20 animaux figurant sur des photos (Animaux exotiques *versus* locaux), et d'en choisir cinq qui devaient être protégés en priorité. Les résultats montrent que les enfants arrivent beaucoup mieux à nommer des espèces exotiques et charismatiques que des espèces locales. Ils savent par exemple reconnaitre un toucan plutôt qu'un merle ; les espèces vues sur les écrans sont beaucoup mieux reconnues que celles vues dans la réalité. Les enfants expriment aussi un fort désir de protéger des animaux qu'ils n'ont jamais vu (contact virtuel) au détriment des espèces locales (contact réel). Bien que cette analyse ne se soit pas étendue aux pays enquêtés, l'ensemble de ces résultats confirme l'inquiétante tendance de la déconnection des enfants de l'environnement local et réel.

En somme, la perception de la biodiversité par les enfants est limitée à l'horizon des médias, et plus globalement par une éducation virtuelle qui prend de plus en plus le pas sur une éducation basée sur l'expérience concrète. Il est donc urgent d'inverser cette tendance en amenant les enfants sur le terrain. Cette approche est l'un des outils les plus efficaces pour étendre l'intérêt des enfants sur l'ensemble des organismes. Pour cela, il est nécessaire de ne pas rester braqué sur les quelques organismes

bénéficiant déjà d'attitudes favorables (oiseaux, gros mammifères). Il est plus efficace de s'intéresser aux espèces les plus mal-aimées dont les serpents donnent un exemple. Sur le long terme il est primordial d'évaluer différentes approches, et donc de disposer de questionnaires et d'analyses standardisés, ce qui n'est absolument pas le cas actuellement.

4.1.2 Test méthodologique du questionnaire (Article 1)

***Sarasvathî** est la déesse*
de la Parole, de l'éloquence, de la sagesse, du savoir et la mère de la poésie.
Elle révéla à l'homme le langage et l'écriture (photo: Népal, 2009 ; JMB)

Factors influencing schoolchildren responses to conservation education questionnaires

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Submitted

Keywords: affectivity, education program effectiveness, environmental education, questionnaire test, media, sample size, survey methodology

Abstract

Questionnaires have been widely accepted as a central tool for assessing people attitude about conservation issues, but their reliability has not been yet assessed precluding the use of standardized surveys that are essential for comparisons across studies, and most importantly for temporal or spatial monitoring of educational programs. We used a large-scale questionnaire to examine controllable (e.g., formulation of the questions, sample size) and less controllable factors (e.g., geographic influence) in young schoolchildren (7-12 years old). To address such methodological issues, we notably analyzed the responses to different versions of one central question: "List five animals that must be protected in priority". Our results indicate that children responded accurately to the questions, even when faced with subtle changes in the phrasing. In addition, small sample sizes (~50 children) provided relatively robust patterns. However, our data also indicated that various factors influence the responses, most notably affectivity towards endearing species, the media, spontaneity and countries. The combined influences of such factors with different formulations of the questions generated important variations in the responses. Therefore, simplification and standardization of questionnaires administered over large spatial and time scales are needed for further surveys to be effective to assess conservation issues.

1. Introduction

To stem the dramatic loss of biodiversity, there is general agreement to recognize the fundamental importance of environmental education, especially in a long-term perspective (Caro *et al.* 1994; Tilbury 1994; Wilson 1996; Bjerke *et al.* 1998; Trombulak *et al.* 2004; Brewer 2006). Because they are more receptive than adults to such efforts, schoolchildren are one of the main targets for efficient educational programs (Feinsinger 1987; Jacobson & Mc Duff 1998; Rivas & Owens 1999; Louv 2008). It is equally important to assess the pertinence of educational programs to specific objectives and the practical aspects of their performance (Engels & Jacobson 2007). Evaluation of the influence of information from various media and educational outlets concerning the biodiversity crisis and conservation education in general, however, is still fragmentary (Lindemann-Matthies 2002; Walsh-Daneshmandi and MacLachlan 2006). Consequently, to better inform schoolchildren, there is a need to investigate the impact of the media and scholarly investment toward conservation problems (Knapp & Barrie 2001; Zoldosova & Prokop 2006). For example, standardized techniques should be employed for comparisons across countries (hence cultures), socio-economic levels, age classes, and to study trends over time.

Surveys can accurately assess public opinion about elements such as awareness of conservation issues, knowledge of biodiversity, and willingness to support conservation actions (Martín-López *et al.* 2007; Lindemann-Matthies *et al.* 2010). Concerning schoolchildren, standard surveys are essential to evaluate the impact of educational objectives – notably, to gauge the progress (or lack thereof) using different approaches (*e.g.*, verbal, field trips, web-based tutorials, *etc.*), various age classes, topics, and different durations of the programs. In this context, written-questionnaires occupy a central place. Theoretically, questionnaires provide excellent information because they employ standardized sets of questions, and rapid collection, formatting and analysis of information. Indeed, a teacher can manage tens of paper-questionnaires simultaneously, but cannot interview more than one child at once. In addition, properly-worded questionnaires provide greater neutrality than an interviewer (Richman *et al.* 1999).

The available literature relative to environmental and conservation education suggests that questionnaires are regularly-used assessment tools. On average we

have observed a limited diversity of the approaches: fixed response design with multiple choices and Likert scale questions were the most employed (Ballantyne *et al.* 2005). However, various methodological complications of such survey types (described in Huddy *et al*. 1997; Tourangeau *et al.* 2000; Groves *et al.* 2009) were either not considered or treated minimally (Table 1). For example, both controllable (formulation of the questions, sample size) and other factors (impact of the media, cultural factors, field experiences) were rarely assessed. Overall, the impact of various factors that can influence the responses of the schoolchildren (Serpell 2004; Groves *et al*. 2009), hence the reliability of questionnaires used for monitoring conservation education was not estimated. The deficit of methodological assessment potentially generates two main difficulties: firstly, to interpret the results from any study; and secondly, for comparisons between different studies (e.g., geographic comparisons) or for long term monitoring (e.g., repeatability of surveys). We emphasize that the lack of standardization is particularly detrimental to assess the impact of conservation education programs. The first step toward standardization is to examine the influence of supposedly important factors on the responses to questionnaires.

Our study reports on a large scale questionnaire (over 2,000 respondents from nine countries). Herein, we focused on only one aspect of conservation education: endangered animals, and more precisely on the species that should be protected in priority. We emphasize that our study is oriented towards methodological issues; hence, the main objectives focused on the reliability of the questionnaire (i.e. impact of different factors on the responses) rather than on the attitudes of the schoolchildren, although these two components cannot be totally separated. For this reason, the results presented in the current study were based on the analysis of a small subset of open items selected in the questionnaire that all revolve around variations of a central question: "List five animals that must be protected in priority". We addressed the following issues with school children aged from 7 to 12 years:

- Do schoolchildren clearly understand the questions; and if so, do they react to subtle changes in the formulation of the questions?

- Can we detect effects of factors that are difficult to control such as spontaneity in the answers, affectivity (e.g., preference for animals that are typically perceived as endearing), or cultural influence (e.g., geographic)?
- What effective sample size is necessary for adequately discern differences in survey responses?
- Is there a taxonomic orientation in the animal species that must be protected in priority according to the schoolchildren?
- Do the animal species listed in survey responses reflect those presented by the media?

Table 1: Survey parameters for 50 studies (conducted between 1991 and 2009) of environmental education based on questionnaires. Three main types of studies were distinguished: Single Taxon Oriented (STO; e.g., survey focusing on one animal species); Broad Environmental Survey (BES); Education Program Assessment (EPA). The number of studies "N" is provided. Median number of children questioned is indicated with range in brackets. Studies were performed in a single country most of the time, rarely two; the influence of the sample size was never assessed. By contrast, several important factors were regularly assessed. Expert review: wording questions, structure of questions, alternative responses, order of questions, and instruction to interviewers (etc.) examined by a committee (Groves et al. 2009). Quality interviews: comparative qualitative questionnaire, cognitive interviewing (e.g., children were asked to describe the meaning of each item …) misinterpretation of the question, etc. Other effects: interviewer appearance, presence of other peoples, influence of a particular event (e.g. weather). *A posteriori* analyses: split ballot approach, introspective test, consistency of the answers for instance. Reliability test: usually tested using Cronbach coefficient alpha and principal component analysis to assess the congruence of the answers.

	N	Median sample size (range)	Mean number of countries surveyed	Sample size tested	Expert reviews	Quality interviews	Other effects	*A posteriori* analyses	Reliability test
STO	15	236 (72-1933)	1.1	0	6	1	1	1	1
BES	13	430 (40-2000)	1.1	0	6	0	1	2	4
EPA	22	459 (10-4000)	1.0	0	8	1	7	1	6

2. Material and methods

2.1 Questionnaires

Following preliminary tests (Ballouard 2005), and after approval by a committee (including teachers specialized on child psychology), we developed a two-phase approach. In 2007-2008, we employed a long questionnaire (a total of 28 different general items; some items contained multi-part questions, not presented here) that aimed to address methodological and fundamental issues. This primary (comprehensive) questionnaire testing was conducted in France only (N=701 respondents that filled up different versions of the questionnaire, see below), and contained partly redundant items so that we could examine consistency in the answers and perform cross-checking. In 2008-2009, we selected the most pertinent questions and used a simplified questionnaire (13 different items) distributed in nine countries over 3 continents (Africa [1], Asia [2], and Europe [6]).

For clarity, and to limit the pressure on the schoolchildren, the questionnaire was introduced as a survey and not an exam. The observer (teacher) explained that the main goal was to assess the perception and knowledge about biodiversity in schoolchildren from different countries. The observer carefully avoided citing any precise example of threatened group of animals, and did not cite particular species (*e.g.*, the term "animal" was used instead of "bear"). The observer also reminded that the term "animal" includes organisms such as insects, worms, etc. – otherwise many children would have overlooked invertebrates owing to incorrect classification (*e.g.*, many children consider that real animals must have eyes; Bell 1981).

The current study focused on one central question: "List five animals that must be protected in priority" (Q1). We assumed that most children would be motivated and that the answers would reflect those species that they considered to be important. This is a typical open question, and many confusing factors could potential influence the answers, providing an opportunity to examine this issue.

2.2 Comprehensive questionnaire

During the first phase, in addition to the main question above, three associated questions were posed to 444 children to test the level of understanding of the respondents.

- "Why the five animals listed should be protected?" (Q2)
- "What are the causes of the disappearance of the five animals listed?" (Q3)
- "How can we protect the five animals listed?" (Q4)

Although superficially similar, the answers for each question were partly divergent. In Q2 for example, the children might have included an affective factor by answering "because I love them," something illogical to do in the response for Q3 because loving animals is not supposed to cause their disappearance. We expected that the answers to Q3 would contain more functional reasoning such as "poaching" or "pollution." The answers to Q4 should propose practical actions such as "building nests." Examination of the answers would inform us about the level of understanding of the children. Indeed, it appears inappropriate to list domestic flies or dogs among the species that must be protected and, if these animals were often cited in the list, doubts about the understanding of the question would complicate the interpretation. If the children used the appropriate register to answer to the three questions, we could discard the problem of understanding and consider other factors (*e.g.*, affective, media influence) more easily. We further explored the level of understanding (N=701 children) by including subtle changes in the formulation of the main question (Q1) in two additional slightly different ways (for a total of three similar variations: Q1, Q5, Q6).

- "List five animals that must be protected in priority" (Q1; N= 350)
- "List five animals that you want to protect in priority" (Q5; N= 228)
- "List five animals that should be saved in priority" (Q6; N= 123)

As described above, the answers associated with each variation of this question were not fully identical. Question 5 contains more affective element than the two others (*i.e.,* the verb "want" refers to personal wishes compared to the terms "must be"), and consequently endearing species such as pets should be more represented. Question 6 is quite similar to Q1, although the terms "should be saved" contain more

potential affective factor compared to "must be protected" that looks like very formal and more associated to a general duty, Q1 correspond to the formulation where duty factor is the most prevalent. This specific test was useful to examine if the way we pose the question actually influences the answers, for instance through the activation of the affective *versus* duty channel.

Following a classification of the responses (see below), the proportion of out of focus answers (*e.g.*, no response or unrelated to the question), of inappropriate answers (related to the topic but illogical for the observer), and of the appropriateness (in the meaning of "expected") of the registers used was a mean to evaluate the questionnaire: notably to examine the consequences of the formulation of the questions.

2.3 Sample Size

The influence of sample size that should be used to obtain a certain level of stability (reliability) in the answers was assessed on French schoolchildren only to limit the marked differences between countries.

2.4 Simplified questionnaire

In the second phase of the study (2008-2009), the simplified questionnaire was translated into nine different languages and checked by teachers for accuracy. We selected 96 classes in Africa (Morocco), Asia (Nepal and Turkey) and Europe (Italy, France, Portugal, Serbia, Slovakia, and Spain) (Table 2). The classes participating were selected randomly within each area. Each teacher received the printed questionnaires accompanied by the aims of the study and detailed instructions for administering the survey. The questionnaires were distributed individually, and the teachers followed the standard protocol to provide instructions using the local language. This protocol was written and distributed to each teacher in order to limit

instruction disparities (we did not record if the instructions were followed exactly). Completing the questionnaire required an average of 30 minutes; thereafter, all questionnaires were collected (N=2,121 schoolchildren, aged 7 to 12 years). In the current study we analyzed the responses to only one question: "List five animals that must be protected in priority" (Q1).

Based on feedback during the second phase of our study, we examined additional methodological issues and re-considered elements that surfaced in the first phase of the study. For instance, we addressed the following questions:

- Did the five animals listed by the children correspond to the most popular species presented by the media (see below)?
- Did student responses contain evidence of the influence of affective factor, for instance through a high citation of endearing animals associated with a strong charismatic "cuddle" factor (*e.g.*, bears, rabbits)?
- Are there differences in responses from different countries? Outcomes to such analyses enabled us to detect geographical and cultural factors (without possibility to tease them apart however).

Table 2: Number of children per country, aged between 7 and 12, participating in the simplified survey concerning the conservation of animal biodiversity (surveyed in 2008-2009). Note that among 656 French children, 444 were subjected to the comprehensive questionnaire (see text for details).

Country	Children numbers
France	656
Morocco	208
Portugal	38
Nepal	116
Serbia	190
Spain	463
Slovakia	162
Turkey	191
Italy	97
Total	2121

2.5 Concise media survey

In order to obtain a broad index of the diversity and proportions of endangered animal species presented by the media we examined websites (using Google) and randomly selected natural history magazines for children (N=5). We identified the animals pictured in websites that resulted from keyword searches using terms such as "endangered animals." We used four languages (English, French, Italian, and Spanish) in order to obtain a broad representation across countries and/or biomes. We limited our analyses of the search results to the first 10 pages. In practice, most of the images (around 20 per page) were retained in the analyses; we discarded duplicates (same picture associated to identical website). Similarly, we examined the front cover page of several natural history magazines that market themselves to schoolchildren (N=5) published between 2007 and 2009 in France and in Italy. Although our methods oversimplified the scope of influence of media outlets, we believe that it corresponded well to what young schoolchildren actually experience.

In addition, our results were consistent and refinements in the procedure would have produced overly-detailed information for the purposes of our study. Notably, the taxonomic diversity of the endangered species presented both in websites or front covers of the magazines was limited. Although using website pictures and front magazine cover pages was a crude estimate of the exact media content, this approach reflected the animal species that benefited from the main emphasis of urgent conservation needs: for instance, every time a tiger was pictured on the front cover of a magazine, the accompanying article indeed focused on this species (packaging should be consistent with content).

2.6 Analyses

All children did not always filled up the questionnaires, thereby generating fluctuations in the sample sizes. Open questions generate open answers. Consequently, we classified the responses into a limited number of categories in order to perform analyses. We first classified the animal species listed by the children. The capacity to utilize a proper scientific taxonomy presents problems to the general public; therefore, we referred to popular taxonomy, irrespective to phylogeny (e.g., giant panda, bear, or fish were all considered at the same level). For some analyses, the animals listed were allocated into six broad categories: mammals, birds, reptiles, amphibians, fishes and invertebrates; because mammals dominated in the responses of the children (see results), our study was biased on this category. We used another entry of classification: we distinguished the native species from the exotic ones in each studied area. For instance, a tiger was exotic for French children, but local for Nepalese from the Teraï region. Following general analyses, we also used another classification to distinguish domestic pets (e.g., guinea pigs) *versus* non-domestic animals (livestock were not considered as pets; Serpell 1989).

We classified the responses to the other open questions (*e.g.*, about the cause of disappearance of animals) into six categories:

1. Out of focus: null or answers was not related to animal conservation.
2. Affective: children clearly introduced an affective factor. For instance using the terms “because they are cute”.

3. Patrimonial: general interest for animal conservation was revealed through sentences referring to a common patrimony, for example for answers containing terms such as "because animals are vanishing."
4. Direct threat: for instance animals should be protected from hunting or poaching, or sentences like "peoples kill animals for their fur."
5. Indirect threat: for instance global warming or habitat loss threatens species.
6. Other: some answers were not easily classified. For instance "to help them."

In order to address the sample size issue, we gradually reduced the total sample by a random selection of the answers. We used a step-wise approach, starting with 100%, and removed randomly an increasing proportion of the sample each time before re-running the analyses three times.

Many statistical analyses were based on proportions (*e.g.,* exotic *versus* local species counted) using analyses of contingency tables. We also used mean individual children score (e.g. mean value of mammal cited calculated using the 5 animals listed per children) to perform analyses of variance (parametric or non parametric). The factor of spontaneity was assessed as a trend in the order of citation in the 5-species listed (this would indicate that children spontaneously first refer to certain species, and to other species only later). Statistics were performed with Statistica 7.1 software. We used a technique devoted to assess niche overlapping in community ecology studies to compare the results about animals cited (hence present) obtained from questionnaires and media survey (ECOSIM, Czekanowski Index, Randomization Algorithm 3; Gotelli & Entsminger 2001). For this specific analysis, we considered that children versus media were two different systems into which counting animals were provided by the analyses of the answers.

3. Results and discussion

3.1. Did children understand the questionnaire?

In spite of the need to regularly decipher awkward prose and numerous misspellings, the children did not confuse the causes for animal rarefaction and the reason why they deserve protection. The proportion of out-of-focus answers

remained low (Figure 1), demonstrating that most of the children correctly understood the general aim of the questionnaire. More interestingly, the three questions (Q2, Q3, Q4) generated different frequencies of the types of answers (Figure 1; χ^2=305.3, df=10, P<0.01). Within each question, the frequency of the response types also differed (Figure 1; Q2: χ^2=139.2, df=5, P<0.01; Q3: χ^2 =351.8, df=5, P<0.01; Q4: χ^2=138.9, df=5, P<0.01). For example, expressions of causality (e.g., poaching threatened animals) dominated the responses when the questions were directed toward the reasons why animals disappear, showing that the schoolchildren understood well the context and responded in an appropriate manner. Children indicated more exotic animal species when the question was formulated in a more formal way (Q1), the general interest of the wildlife became more important (Figure 2). The affective factor in the responses (*e.g.,* use of the words such as "love, cute, adorable…") was well represented in the questions where it was expected (Q2); in contrast, this factor was almost totally absent when it would have been illogical to refer to it (Q3 and Q4; Figure 1). Many answers to Q2 contained a patrimonial value, and to a lesser extent an affectivity factor. In other words, the children logically considered that it is necessary to protect animals because they are threatened but also because they love them; but almost none incorrectly proposed that the cause of their disappearance is because they love them. Similarly, almost all children correctly suggested reducing direct and indirect threats (*e.g.*, poaching, pollution, *etc*.) to better protect animals. This first result is of major importance as it indicates that surveys are accurate tools to assess the effectiveness of conservation education programs in a crucial schoolchildren age class.

Besides such general understanding of the topic of the questionnaire, the schoolchildren understood well the respective meaning of each question. Indeed, the children responded differently to the subtle variations in the phrasing of an otherwise identical question (Q1 *versus* Q5 or Q6). For example, the proportion of pets in the answers (χ^2=4,847.1, df=2, P< 0.01) or of exotic animals (χ^2=34.1, df=2, P< 0.01) was influenced by the main verb used (Figure 2). For instance, the use of verb "must" *versus* "want" generated changes in the proportion of answers containing an affective factor (*i.e.*, proportion of pets cited: χ^2=68.8, df=1, P< 0.01; Figure 2). Indeed the phrase "must be protected" involves a general duty factor whilst the phrase "you

want to protect" refer more to a personal wish. Therefore, a larger proportion of family animals (mostly dogs and cats) was found in the answers to the question Q5 compared to the responses to Q1. In contrast, the meaning of the phrase "must be protected" was similar to "should be saved," and the responses tended to converge. The responses of the children reflected the fact that they correctly differentiated words that might have otherwise been considered as secondary to the aim of the question, because the primary goal was to obtain a list of five animals.

Further analyses showed that the influence of affectivity in the responses was entangled with other factors such as spontaneity or media impact as presented below; it is therefore of prime importance to take into account such effects (i.e. the importance of the affective factor for conservation issues) to set up standard survey techniques for conservation education.

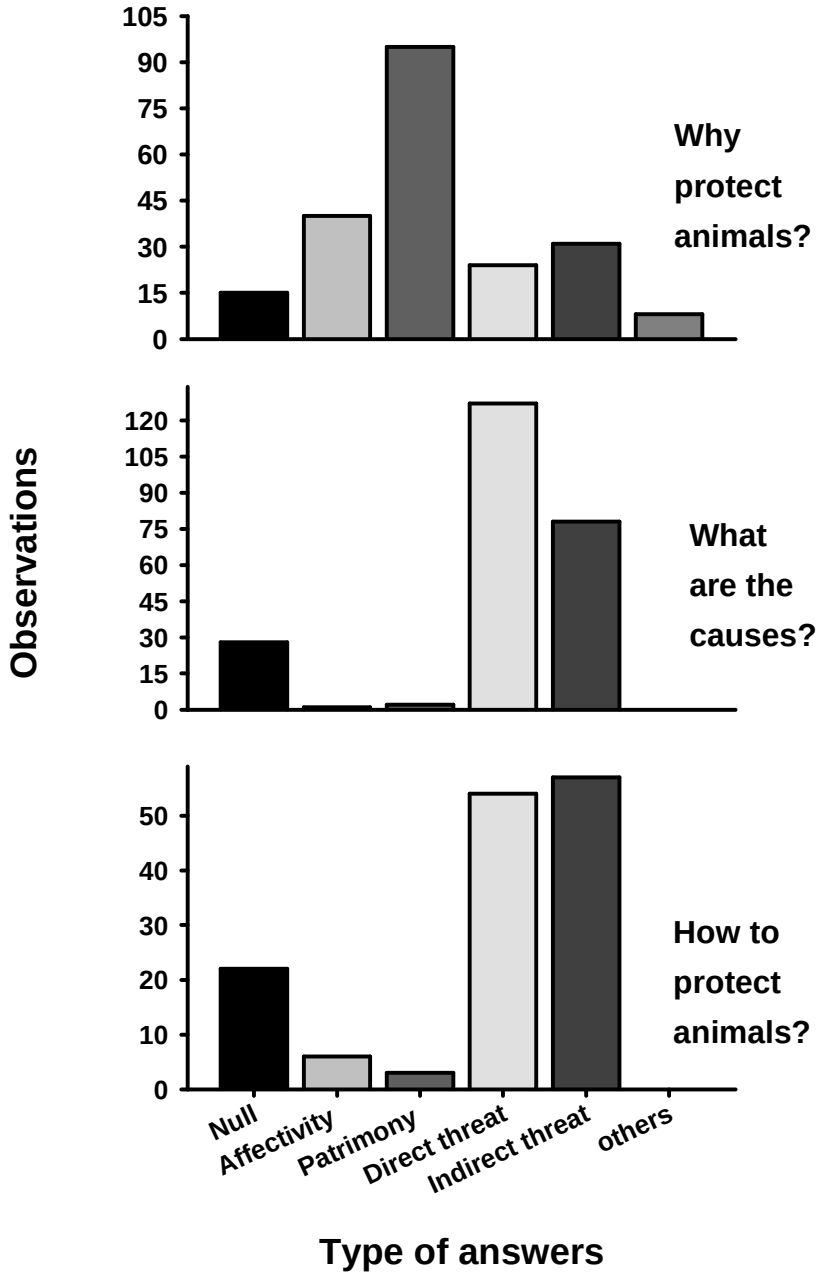

Figure 1: Variations in the responses to three questions ("Why the five animals listed should be protected", Q2, top graph; "what are the causes of the disappearance of the five animals listed", Q3, medium graph; "how can we protect the five animals listed", Q4, bottom graph) about the disappearance of animals. The X-axis provides the main types of answers (see text) and the Y-axis the total number of answers. See text for statistics.

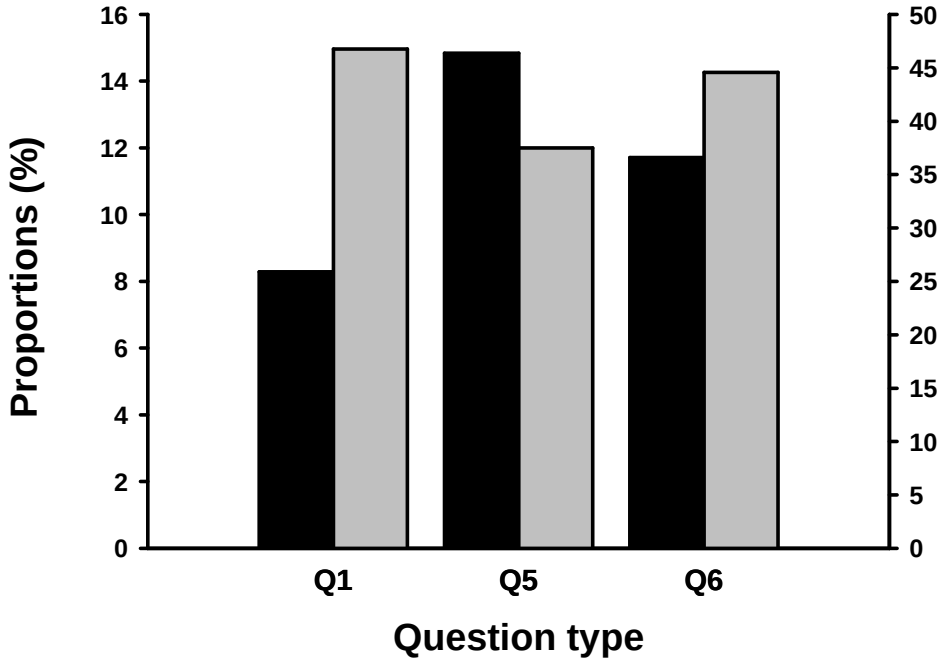

Figure 2: Variations in the responses to three subtle modifications (underlined) of the formulation of the main question, "List five animals that must be protected in priority" (Q1), *versus* "… you want to protect…" (Q5), or "…should be saved…" (Q6). All the animals listed by the children tested are pooled (total number of animals cited >3,000). Black bars and left axis correspond to the proportion of pets in the responses. Grey bars and right axis correspond to proportion of exotic animals in the responses. See text for statistics.

3.2 Spontaneity in the responses

Because the surveys asked children to list five animals, we had an opportunity to examine if the responses were influenced by their position in the list. We hypothesized that, because the children manifested a strong willingness to fill up their questionnaire, the first animal listed would be more influenced by spontaneity than the next one, and that more reflection by the child would have been required to generate additional taxa for the list. The mean proportion of the most cited types of animals (mammals and pets), decreased as the children added animals to the list (repeated measure ANOVA with the five consecutive responses of the animals listed as the repeated variable, and the type of question [Q1, Q5, Q6] as the factor: specific effect of the position of the animal listed [i.e., time]: $F_{4, 2140}=6.7$, $P<0.01$, and $F_{4, 2112}=5.2$, $P<0.01$ for mammals and pets, respectively; Figure 3). An influence of the

type of question (Q1, Q5, Q6) on this trend was detected using pets in the analysis (Wilk λ=0.94, $F_{10, 1048}$=3.21, P<0.01; interaction $F_{8, 2112}$=1.92, P=0.05). This later analysis thus revealed that the importance of the affective factor was better assessed when interaction with spontaneity when the order of the five animals listed was taken into account: the prevalence of pets decreases when the question was formulated with the verb "want" whilst the use of the verb "must" prompted relatively stable and low prevalence of pets in the responses (Figure 3). The weight of the affective factor was limited when the question is phrased in a more neutral way (e.g., Q1 *versus* Q5). This result suggests that the main question written with the verb "must" produced less complication, and this phrasing was therefore retained for the simplified questionnaire distributed in the nine countries.

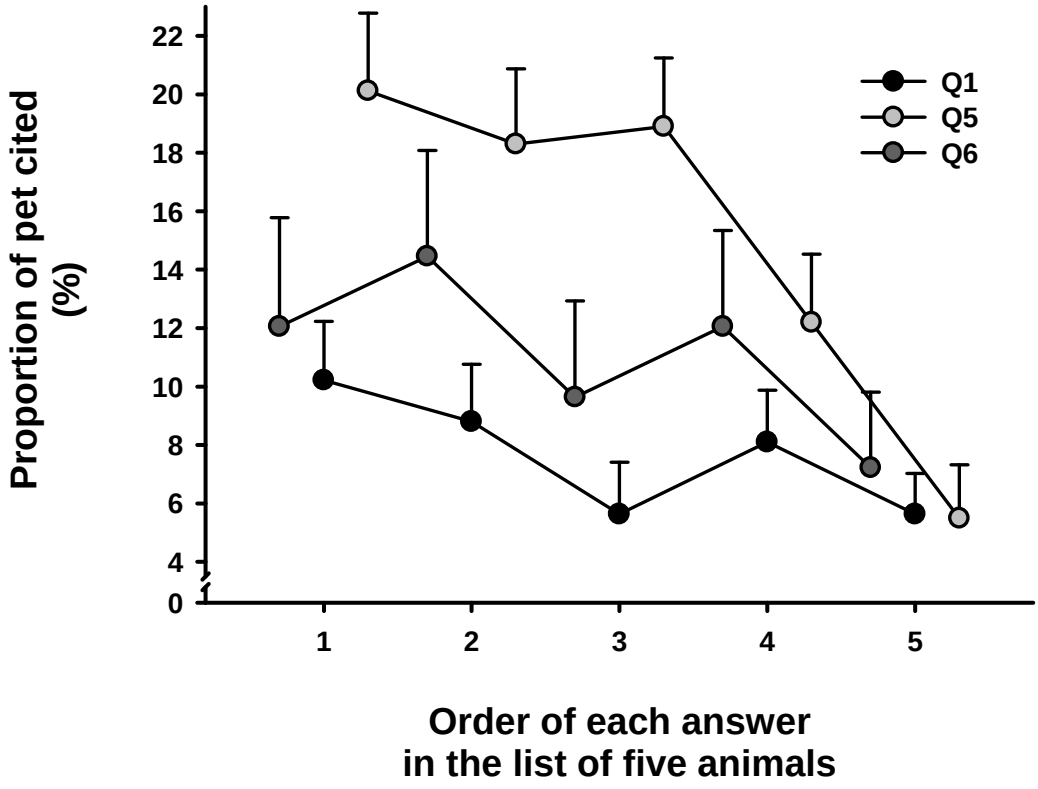

Figure 3: Effect of the type of question (Q1, Q5, Q6) and of the French children (N=444) on the proportion of pets cited (an indicator of affectivity). Each symbol represents the mean proportion (±SE) of pets cited in the each of the successive answers proposed by the children to elaborate a list of five animals. Over time (*i.e.*, the succession of five answers), the proportion of pets among the animals listed decreased, and such trend was different for each type of question (see text for statistics), suggesting that a spontaneous factor was involved.

3.3 Sample size

Sample size is a critical statistical element seldom considered in questionnaire surveys (Table 1). Comparing the occurrence of the most cited types of animal in the student responses (*e.g.*, mammals and exotic species, see below), our data indicated that the mean proportions were relatively stable with a small sample size, corresponding broadly to one or two typical school-classes, the typical level at which most practical operations of conservation education are conducted (Figure 4). Large sample sizes, such as those employed in several countries (Tables 1 & 2, *e.g.*, France or Spain in the current study) might not provide a better signal than the small sample sizes. The predominance of a relatively limited number of iconic animals could explain such a result. Indeed, querying a large number of schoolchildren is probably unnecessary in order to ascertain that bears or tigers are often cited among those animals that must be protected.

Importantly, the random sub-sampling procedure was performed on the whole data set (all schoolchildren pooled before random sub-sampling), and local peculiarities were thus minimized. But using well identified units (classes, N<30 children; schools, 30>N>150) produced results not perfectly aligned to the gross mean values (Figure 4). On average, values of most subsamples did not markedly deviate from the average values obtained through the random sub-sampling: the proportion of mammals or exotic animals remained within 10% around the value calculated on the whole sample size (i.e. distribution of grey crosses in Figure 4). However, several outliers (classes or schools) were apparent (Figure 4). Interestingly, such classes (N=2) or schools (N=1) benefited from a specific important environmental education program oriented toward local fauna (mostly birds) during the previous months, resulting into a decrease of the prevalence of exotic fauna (exotic mammals mainly) with a concomitant increase of wild local fauna in the citation rate. Overall, basing survey studies on small sample sizes remains tenuous.

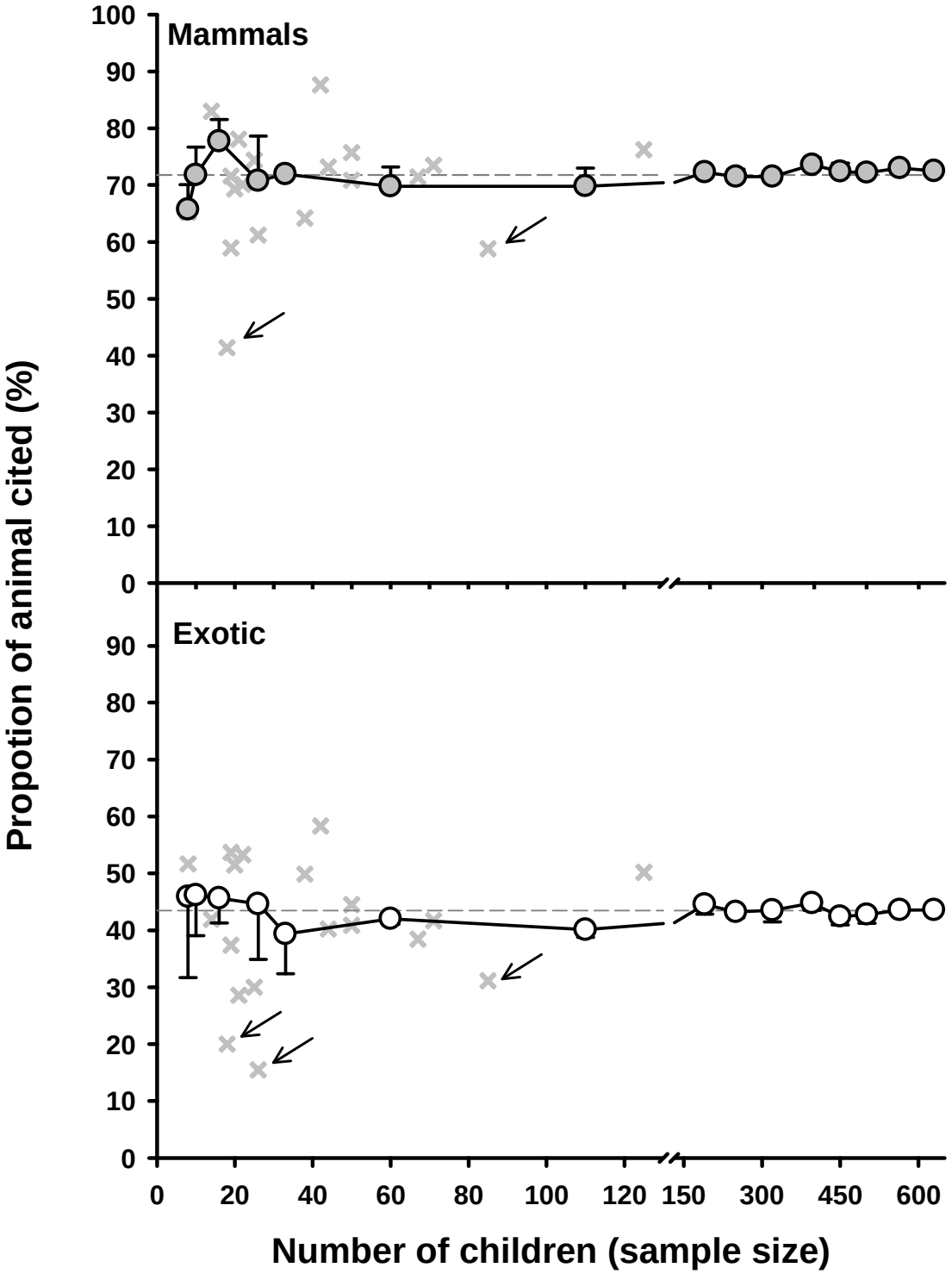

Figure 4: Influence of sample size (number of French children questioned) on the proportion of mammals (top graph) and exotic animals cited (bottom graph). Error bars around mean values denote ±1 standard error. The dashed grey lines indicate a mean value calculated using the 15 means, such lines enable to visualize the sample size effect. Crosses indicate values obtained for specific classes (N<30) or schools (N>30). Arrows show the sole cases where field trips oriented towards local fauna, especially birds, were performed two months before the survey.

3.4. What are the animals must be protected in priority according to the children?

To this central issue, most of the 2,121 children surveyed proposed five animals that must be protected (4.6 animals on average), generating a total sample size of 9,771 responses instead of 10,605 expected in an ideal system. More than 400 different animals were cited with variable taxonomic accuracy; from specific to broad levels (*e.g.,* polar bear *versus* insects). Herein, we focused on the most cited animals. By arbitrarily selecting the responses that contributed to at least 1% (range 1.05% - 5.39%) of the citations, 28 animals were retained for further analyses. These 28 taxa represent more than 67% (N=6,409 responses) of different animals listed (Table 3).

Mammals and/or exotic animals overwhelmingly dominated the animals cited; for instance, mammals represented roughly 80% of the most cited animals (Table 3). Such prevalence of mammals was not surprising; indeed almost all iconic species are contained within this clade. Large and endearing mammals are the most popular organisms (Swanagan 2000; Barney *et al.* 2005; Bexell *et al.* 2007); notably bears, tigers or wolves (exotic species for most of the children surveyed), and pets (Czech *et al.* 1998; Ward *et al.* 1998; Lindemann-Matthies 2005; Maresova & Frynta 2008; Snaddon *et al.* 2008). Many of these species are indeed threatened, but considering worldwide conservation needs, they also receive disproportionate amounts of financial support, publicity, and scientific investigation and redressing such bias is required (Bonnet *et al.* 2002; Clark & May 2002; Feldhamer *et al.* 2002; Seddon *et al.* 2005; Tisdell *et al.* 2006). All the other animals first cited were vertebrates.

Surprisingly, although iconic animals, such as polar bears, tigers or giant pandas, were particularly well represented, animals not particularly endangered such as cats and dogs were top ranked. This result echoes psychological studies performed on children that demonstrate the importance of affective and emotional factors in their attitude (Iozzi 1989; Wilson 1996; Pooley & O'Connor 2000; Vining 2003; D'Argembeau & Van der Linden 2004; Littledyke 2008). Therefore, responses somewhat inappropriate at first glance, such as the high rank occupied by pets (cats and dogs essentially) reflects the fact that the children certainly want to protect the animals they love the most (Melson 1991; Prokop *et al.* 2008). Perhaps also young children consider that cats and dogs are endangered in the same manner than really

threatened species; the distinction between individual animal, population, and species might be unclear for them, at least in terms of protection priorities (Asworth *et al.* 1995). We believe that the strength of the affective factor is the main cause for the high rank of the mammals in general and more precisely of endearing species and pets in the answers, that young children do understand well conservation priorities, and also that the influence of the affective factor decreases rapidly in older schoolchildren age classes (unpublished survey analyses and experiments) (Kellert 1985).

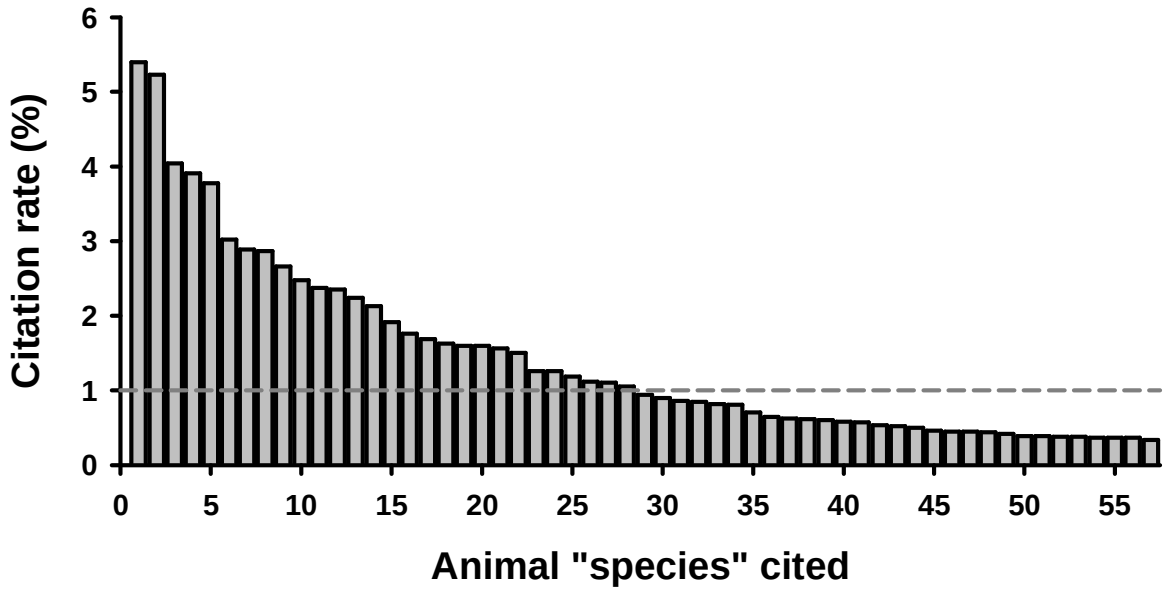

Figure 5: Frequency of the first 50 animals (out of a total of 407 species) cited most often by schoolchildren from nine countries surveyed in 2008-2009 (all data pooled). Each unit on the X-axis indicates an animal "species" actually cited at various taxonomic levels by the children, from subspecies (e.g., Bengalese tiger) to a broader level (e.g., butterfly). The values on the Y-axis are calculated as the percentage of citation per animal "species" relative to the total number of citations (N=9,771). The grey dashed line indicates a level of 1% citation rate, 28 animal "species" ranked above this value.

3.5 Concise media survey

Given the prevalence of mammals and pets among the responses, the possible influence of media was also an important potential factor to assess in determining the assignment of priority. We identified 158 different animals in the media (N = 507 source pictures). Iconic animals, essentially exotic mammals, were overwhelmingly used to illustrate the front cover of magazines or websites (Table 3). A large proportion of the animals frequently displayed by the media were also frequently cited by the children, notably those situated on the top of the lists (*e.g.,* bears, tigers and giant panda). Dogs and cats are also used by the media, despite the fact that they are not particularly endangered. Local wild animals were poorly represented.

We assessed the similarity between the sets of responses obtained from children's surveys and that generated from reviewing various media sites respectively. For this analysis, we compared the occurrence of the 28 most cited animals both by the schoolchildren and in the media (Table 3); hence, we compared 39 animals (because several animals were present in one set only). Mean similarity index (Czechanowski index, 10,000 iterations) provided a value of F = 0.593 with a variance of simulated indices = 0.0003, indicating that the two data sets greatly overlapped. Although we did not survey one of the main media sources for children (i.e., television – radio and newspapers being less important; Liebert & Sprafkin 1988), there is little doubt that convergent trends would have been found: a relative few iconic animals, such as tigers and polar bears, occupy most the space (Clucas *et al.* 2008). Because the average amount of time that children are presented with media is considerable (Christakis *et al.* 2004; Thakkar *et al.* 2006), in fact greater than the amount of time spent on field-based wildlife education (Hofferth & Sandberg 2001), and because media sources reliably influence children to the detriment of field and personal experience (Chawla 1988; Bogner 1998; Villani 2001; Brewer 2002; Erdogan & Usak 2009), such similarities are not surprising.

Dogs and cats were also frequently used by the media despite the fact that they are not particularly endangered or wild animals. A closer inspection of the data in the media showed that problems of cruelty against animals are regularly mixed (or at least not clearly distinguished) with problems of species conservation, both in the web sites and in the paper magazines. Therefore, our searching techniques did not

make the distinction between these two types of problems related to endangered animals. Further investigations to examine to what extent such distinction is clear for young children (7-12 years old) would be necessary.

Our study was not designed to tease apart the respective influences of media from affective factors for the prevalence of typically endearing animals; indeed media may simply use an affective factor to increase their audience (note, the media neglected ectothermic animals, except tortoises that are popular). But this issue lies beyond the scope of the present study. Whatever the case, this reinforces the notion that the affective factor must be taken into account in young children.

Table 3: A list of the animals most cited by children (all countries pooled, N=2,121 children), or counted during the media survey (both conducted in 2008-2009). Animals present in both lists are shaded in grey.

Animals (children)	Number	Animals (Media)	Number
Cat	527	Tiger	31
Dog	511	Panda	28
Tiger	395	Polar bear	24
Elephant	382	Wolf	20
Lion	369	Elephant	16
Snake	295	Tortoise	15
Panda	282	Rhinoceros	15
Rabbit	280	Dog	14
Monkey	260	Bear	10
Bird	242	Parrot	10
Bear	232	Lynx	9
Fox	230	Whale	9
Horse	219	Gorilla	9
Dolphin	208	Dolphin	8
Polar bear	187	Lion	8
Tortoise	172	Eagle	8
Cow	165	Koala	7
Wolf	159	Leopard	7
Fish	156	Cat	6
Whale	156	Seal	6
Giraffe	153	Tit	6
Crocodile	147	Otter	5
Lynx	123	Toucan	5
Rhinoceros	123	Snow leopard	4
Wild boar	116	Squirrel	4
Eagle	109	Giraffe	4
Squirrel	108	Kangaroo	4
Penguin	103	Iguana	4

3.6 Geographic factor

Because mammals, exotic animals and pets were important in the responses, we used this classification as a fulcrum to assess the potential influence of geographic factor. Our objective was not to analyze in detail the influence of factors associated with geography (*e.g.*, local biodiversity, culture, school system, and media all potentially interfere in a complex way). Instead, we assessed differences in responses from children inhabiting different countries. Using the frequently-cited animal types, we found differences in responses from children in different countries (respectively comparing the mean proportion of mammals, exotic animals and pets, Kruskal-Wallis ANOVAs: $H_{8,\ N=2,116}=62.3$, $P<0.01$; $H_{8,\ N=2,098}=90.6$, $P<0.01$; $H_{8,\ N=2,116}=114.0$, $P<0.01$; Figure 5). For instance, the number of mammals cited by Nepalese children *versus* children in other countries differed by more than 25% (maximal difference between two countries: 36%; Figure 5). Similarly, the proportion of pets in the responses varied from more than 59% between Turkey and other countries (maximal difference between two countries: 89%; Figure 5). The prevalence of mammals in general, however, and the relative high rank obtained by pets (few species involved) remained unchanged; the broad patterns described above were consistent across all countries. We found however significant differences.

Further analyses indicate that interactions between different factors, such as spontaneity, access to media were involved (unpublished results). Our interpretation is that, although comparisons within relatively homogeneous countries (e.g., those within Western Europe) are probably reliable, comparisons between heterogeneous countries (e.g., Nepal *versus* Spain) should be conducted with greater prudence (Purdie *et al.* 2002). The encouraging result is that, despite such disparities, similar indicators (*e.g.*, proportion of iconic mammals) can be used to assess opinions of schoolchildren.

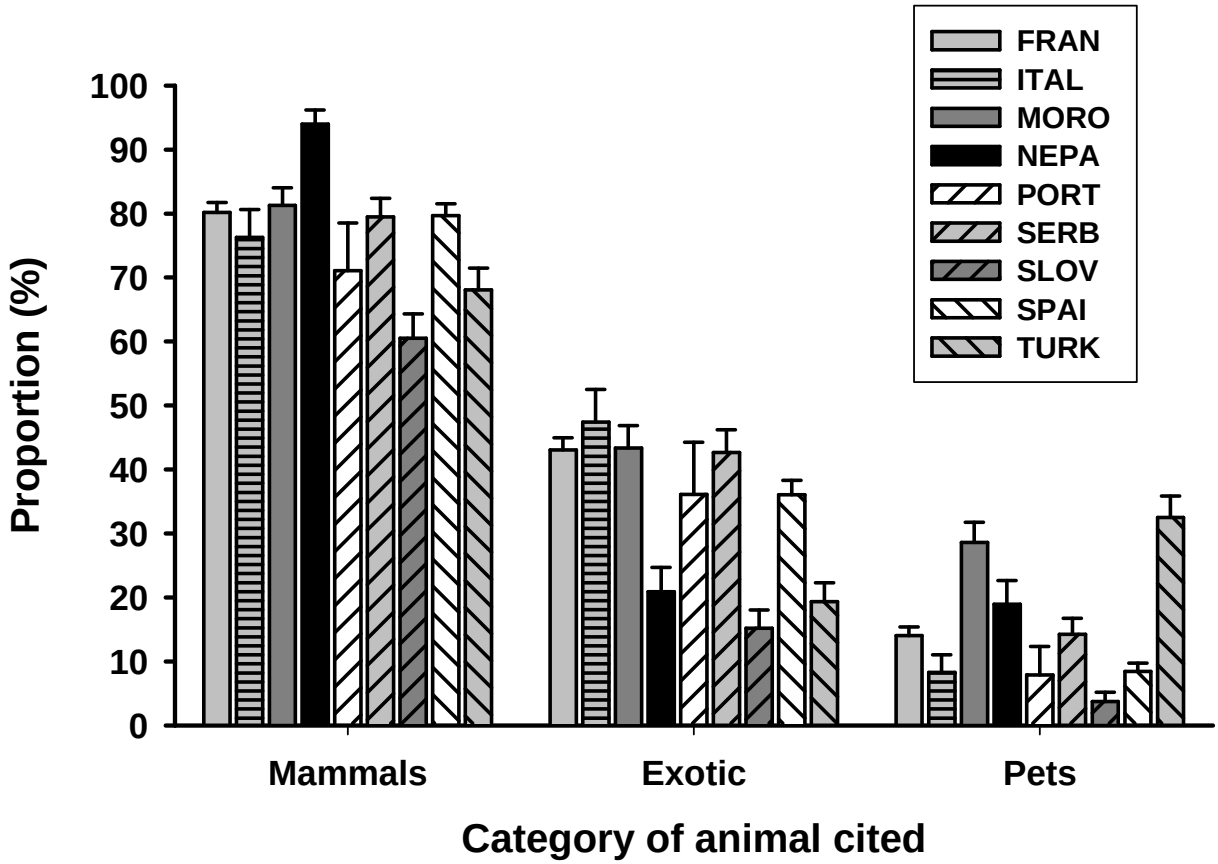

Figure 6: Comparisons of the proportions (mean values expressed +1 SE) of mammals, exotic animals, or pets cited by schoolchildren from 9 countries surveyed in 2008-2009. See text for statistics.

4. Conclusions

There are few substitutes for questionnaires as tools for routinely monitoring trends in public opinion, particularly the impacts of education on conservation objectives. To our knowledge, this study is the first to explore the influence of multiple factors on children responses, and thus to assess the reliability of conservation education questionnaires. Our results based on central question about conservation priorities revealed clear patterns not described previously. Broadly, the inspection of our survey results suggests both encouraging and cautious messages for the use of questionnaires in monitoring conservation education.

Our results suggested a high level of confidence in the quality of the responses indicative of high levels of understanding and reliability: 1) a low occurrence of out-of-focus answers; 2) the accuracy of the responses to different questions; 3) the detection of the influence of subtle changes in the formulation of the same question;

and, 4) the consistency of the prevalence of major items (e.g., mammals) in five consecutive responses. Even questionnaires based on small sample sizes (*e.g.*, 30<N<100) provided useful patterns, and thus questionnaires should be administered over large spatial and time scales rather than focusing intensively on a given locality.

However, other results revealed a strong influence of different and possibly intermingled factors on the schoolchildren responses; notably affectivity, spontaneity, media, and countries. Thus another outcome of our study is that the responses are potentially sensitive to many poorly controllable factors (e.g. cultural, media…), reinforcing the importance of reliability assessments in these studies.

Taken together, these results support those of previous studies, and indicate that questionnaires previously used for monitoring conservation education were very useful (Table 1). Unfortunately, the types of questionnaires used were not homogeneous (Table 1), and they were often based on long and/or complex assessment, hence poorly practicable systems (*e.g.*, Kellert's typology or Likert scale), but not always (see for instance Balmford *et al.* 2002, or Snaddon *et al.* 2008 for concise and efficient surveys). In most situations, it would be difficult to collect and analyze survey data based on a long suite of questions; the conclusions reached by such efforts would likely be complicated by the demographics of those people completing the surveys. More importantly, the absence of a common approach precludes any generalization of the results and prevents monitoring trends over time; something however essential for assessing the impact of conservation education programs in schoolchildren. For practical reasons, and to allow comparisons across studies, standardization and simplification are required.

A practical message that can be derived from our results is that few iconic animal species and pets should be used as indicators, at least with young children (7-12 year old). For instance, to examine the impact of educational programs oriented to redress taxonomic bias in conservation, such indicator species is easily tractable. The impact of field trips that focus on neglected components of biodiversity (e.g., invertebrates, plants), or that use different methods (handling animals *versus* watching them), can be assessed by comparing the position of such indicator species in the answers to a single question: "Which animal species must be protected in

priority?" Analyses of the indicator species before and after the field session, both in the short and long term, might reveal the effectiveness of the technique employed with a possible increase in the rankings of local animals (or plants) relative to the dominant exotic and iconic species.

We fully appreciate that our data and conclusions represent an early examination of a neglected issue, and we hope that our conclusions will prompt further study and validation. We nonetheless believe that our suggestions for improving the toolbox for conservation education are justified and timely. For routine surveys, we advocate the use of a simplified questionnaire, possibly inspired from the results presented here or from other efficient and simple surveys. For instance, simple school standard survey (4S) should be developed to better assess the efficiency of alternative methods (Internet searching *versus* handling wildlife during field trip).

Acknowledgments: we thank Dr. M. Place for his help to set up the questionnaire, and the teachers and children involved that kindly participated to this study.

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4.1.3 Connaissance et intérêt pour les animaux chez les enfants et les médias (Article 2)

JMB

Which species do you want to protect? Virtual exotic biodiversity overwhelms local biodiversity

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Word count: 6204

Submitted

Abstract.

Environmental education is essential to stem current dramatic biodiversity loss, and childhood is considered as the key period for developing awareness and positive attitudes toward nature. Children are strongly influenced by media (either directly or indirectly), internet being an important channel providing information on species diversity and environmental concerns. However, most media focus on few iconic, appealing, and usually exotic species to deliver messages about biodiversity and conservation. In addition, virtual activities are replacing field experiences. This situation may curb children knowledge and concerns on local biodiversity. We assessed schoolchildren's perception of local *versus* media animal biodiversity (i.e., knowledge and willingness to protect) using two complementary surveys (open written questions and closed identification of animal species with pictures). Our results suggest that children's perception of biodiversity is mainly limited to internet contents, represented by few exotic and charismatic "protectable" species. Knowledge of local animals is meagre, suggesting a worrying disconnection between children and their local environment. Indeed, schoolchildren are more prone to protect "virtual" (unseen, exotic) species rather than local species. Our results reinforce the message that environmental education must also focus on outdoor activities to develop real conservation consciousness and concerns about local biodiversity.

Keywords: conservation, education, exotic biodiversity, local biodiversity, media, schoolchildren

INTRODUCTION

Environmental education is one of the fundamental tools required to reverse the current trends of the biodiversity loss [1-4]. Childhood is the key period to introduce environmental education owing to the strength and lasting quality of an early relationship formed between children and the natural world [5-9]. Using animals is particularly efficient in encouraging such a relationship, due to the affective relationship that children easily build with animals [10]. Animals, in general, may therefore provide an efficient means to connect people with their natural environment [10, 11]. In practice, personal experiences, knowledge and likeability are important determinants in the establishment of such a bond [12-16]. In addition, to develop positive attitudes towards global biodiversity, environmental education should encompass wide species diversity, notably by including less popular and neglected taxa [17-19]. Overall, environmental education programs should focus on children and should incorporate a broad range of species representative of global biodiversity.

Attitudes of children toward nature are influenced by family, personal experiences, media, and school [20]; with the prevalence of the media increasing over time. For instance, television occupies a central place in the lives of children [21-23], even supplanting the role of the family and substituting outdoor and social activities [24]. More recently, internet has become the main source of information for children; it is also one of the main channels for social interactions. These effects are cumulative, and they have generated a recent shift in children's behaviour, with a considerable amount of time spent in front of a screen to the detriment of outdoor activities [25-29]. Importantly, current academic education systems favour internet use. This form of media is indeed a major pedagogical tool for most teachers; for example, in 2005, almost 100% of public schools in the USA had access to the internet, compared with 35% in 1994 [30]. Internet access is considered as a major progress to connect children to the world whilst field trips remain peripheral [30, 31]. As a consequence, media (especially internet-based) are the main channels providing information on species diversity and on environmental issues [32]. Accordingly, conservation educators rely on the internet to develop environmental consciousness and to raise concerns about biodiversity conservation [33].

In general, messages about conservation issues are based on a few iconic, flagship and "likeable" species (e.g., polar bear, dolphin, etc.) that benefit from a strong charismatic "cuddle factor" [17, 34, 35]. Therefore, the most demanded and easily accessible information on biodiversity is represented by exotic and appealing animals. This trend tends to "condition children to think that nature is exotic, awe-inspiring and in far, far away, places they will never experience" [36]. This situation likely explains the extremely poor level of knowledge of children about local biodiversity [18, 19] along with the detrimental disconnection between people and their biological environment [34, 37, 38].

Overall, children's everyday life has largely shifted to the indoors over the last decades [39]. Virtual information and vicarious experiences are progressively substituting direct and real personal experiences [34, 40, 41]. For instance, although children are able to recognize more than a thousand corporate logos, or hundreds of Pokémons along with their virtual life history traits [18], they can only identify a handful of animal and plants that are native to their home environment [18, 40]. In this context of growing virtualisation we need to assess how these changes influence perception of local biodiversity, including knowledge and willingness to protect the local environment [23, 42].

Using two complementary questionnaires, the aim of our study was to 1) assess if the perception of global animal biodiversity by children is mainly lead by information available in media (e.g., internet); and 2) assess the knowledge of children and their willingness to protect local *versus* exotic animal biodiversity.

METHODS

Following preliminary tests [43], and after approval by a committee (including teachers specialized on child psychology), we administered a relatively comprehensive questionnaire to 701 school children (7-11 years old, 2007 and 2008) to assess their knowledge about animal biodiversity and willingness to protect threatened species. This questionnaire was based on a total of 28 different main items; some items contained multi-part questions that aimed to address methodological and fundamental issues (not presented here). Analyses showed that

the children's answers were reliable: almost all the children (90%) correctly understood the goal of the study and accurately responded to questions. For instance, to the question "what are the causes of animal disappearance?" most of the answers (86%) correctly identified direct (e.g. poaching…) or indirect (e.g. habitat destruction…) factors, whilst only few children provided out-of- focus (12%) or not-well formulated (2%) responses.

For the current study we used a subset of responses to a written questionnaire distributed during school time to 251 schoolchildren (age 7 to 11) from both rural and urban areas. The schoolchildren originated from 9 randomly selected schools situated in the Middle-West of France. We ensured that the school classes were not previously involved into any educational program concerning animal biodiversity or wildlife threats. For clarity, and to limit the pressure on the schoolchildren, the questionnaire was introduced as a survey and not an exam. The observer (teacher) explained that the main goal was to assess the perception and knowledge about biodiversity in schoolchildren. The observer carefully avoided citing any precise example of threatened group of animals, and did not cite particular species (e.g., to introduce the questionnaire, the general term "animal" was used instead of "dolphin"). The observer also reminded the schoolchildren that organisms such as insects or worms belong to animals; otherwise many children would have overlooked invertebrates [44].

Open survey

To assess the animal species that schoolchildren want to protect spontaneously, we asked them to list five different animal species they were willing to protect: "list five animals that must be protected in priority". The schoolchildren were also asked to explain where each of the cited species was observed: in the field, in their garden, in a zoo, on the television, in another media, etc. Animals were either really observed (i.e. living animal seen in the field or in a zoo for instance) *versus* virtually observed through a media (e.g. television, internet, magazine…). Several animals were observed in more than one situation (e.g. a fox can be seen in the field, in a zoo, or on television); others were almost only observed in only one situation (e.g. giant panda in the media).

The response database was used to gauge the diversity of the species that the children considered as essential to protect. In other words, because almost all the children correctly identified the causes for animal disappearance, we also considered that they understood well other questions and that the list of five animals they provided largely reflected the species that they wanted to protect in priority. Henceforth, for simplicity, we used the term "protectable species" (or "protectability" when assessed as proportions) to refer to the species listed by the children. We retained in such list of "protectable species" all the animals cited by the children irrespective of their actual conservation status (e.g. disregarding IUCN red list). Indeed, we aimed to poll the children, not to test if they correctly ranked animals in an official list of threatened species. This spontaneous biodiversity was then compared to the biodiversity presented in one of the most influential media: internet (see "Internet and endangered animals" below).

Constrained survey

Analyses of the schoolchildren surveys have shown that spontaneity is an important element that influences children's answers and that can limit the number of local species listed (unpublished data). For instance, children tend to cite the species they recently observed. Consequently, domestic pets and exotic species were over-cited as "protectable" species during the open survey (69.9%, unpublished data), somehow masking the biodiversity of local "protectable" animals that potentially exists in the mind of the children.

To assess this issue, we used an additional method to circumvent the children's spontaneity. We provided to each schoolchild a colour plate with twenty animals pictured in a standard way. We balanced the numbers of iconic exotic species (e.g., Polar Bear), non-iconic exotic species (e.g., Pangolin), iconic local species (e.g., Red Fox) and non-iconic local species (e.g., House Centipede). Importantly, none of the presented local species were cryptic (i.e., very difficult to observe); conversely we selected common and conspicuous animal easily spotted in gardens, city parks or at home (e.g., the European Black Bird, *Turdus merula*). We mixed species from six broad taxonomic groups (Mammals, Birds, Reptiles, Amphibians, Fish and Invertebrates). A total of 37 different species (N=16 exotic species and N=21

local species) were displayed on two different plates (3 species were identical on both plates). The two plates were presented to a total of 446 schoolchildren (N=315 for the first plate and N=131 for the second plate). For each picture, the children were asked if they had ever observed a live specimen (i.e., ever seen the animal in person, not an image, regardless the location of the observation; in zoos, gardens, etc.), to provide precisely the name for each species (whenever possible, to the lowest taxonomic level), and then to list 5 species (among the 20 presented on the plate) that must be protected.

Internet and endangered animals

Among various media (magazines, television, books, internet, etc.) we selected internet for several reasons. Firstly, internet is currently used by most school teachers as a predominant pedagogical tool. Secondly, it has been shown that internet is also the prevalent media used by people to access scientific information [45, 46], and a schoolchild interested by a particular topic will use the internet as the most rapid, rich and convenient source of information. Thirdly, the prevalence of the internet is likely to increase over time, especially in the scholastic environment. Lastly, the similarities in the questionnaire and internet searching procedures allowed a straightforward comparison of the two data sets (see below).

To produce a database comparable with the schoolchildren database, we used a realistic approach likely adopted by most children. Notably, we relied on the identification of animal species based on pictures obtained from the most used search tool (http://images.google.fr/). We used keyword-based searches using 6 different sets of keywords (i.e., “endangered animals”, “animals disappearing”, “animals extinction”, “protected animals”, “animals saved”, “threatened animals”) and duplicated this search by replacing “animals“ by “species” (total of 12 different keyword phrases). Although this method likely oversimplified the current richness and complexity contained in various media outlets, and hence the potential impact on children’s access to threatened animal information, we believe that it corresponds well to what young schoolchildren are experiencing during a comparable search session (pers. obs.). Indeed, virtually no child was aware of specialized websites (e.g.,

IUCN red list, etc.), and probably few would have been able to navigate or use them effectively.

For each set of keywords, we sampled twenty times 5 successive pictures (e.g., comparable to the five species listed by the schoolchildren, see above). Each picture was identified to the lowest taxonomic level (species level in most cases) by the three authors. We discarded duplicates (same picture associated to identical website). We obtained a total of 237 samples representing 1185 animal pictures.

Comparison between schoolchildren responses and internet pictures

In order to compare these two datasets representing the animal diversity of "protectable" species perceived by the schoolchildren versus available on the internet, we used statistical approaches developed to compare the diversity patterns of different pseudo-communities, and notably we used estimates of species richness and shared species.

We performed richness estimates to test the effectiveness of our sampling of the diversity of "protectable" species perceived by the schoolchildren and available through the internet (Chao estimator, [47]). We calculated similarity indices (Morisita-Horn index, [48, 49]) to quantify diversity overlap between schoolchildren and internet. These analyses were performed using Estimates 8.2 [47].

The differing level of biological knowledge between schoolchildren and the authors (who identified internet pictures) can influence the taxonomic level and the accuracy of the species identification (e.g., a "Humpback whale" would be accurately identified by the authors but more likely classified as a "Whale" by most schoolchildren). This might artificially affect the similarity indices computed between samples. As a consequence we produced additional datasets adjusted to the taxonomic knowledge of schoolchildren ("top-down" approach). The images gathered through the internet were saved and re-identified by another group of schoolchildren (not involved in the other types of surveys) to the lowest taxonomic level (e.g., some bird species were simply named "bird", but such imprecision applied equally to the entire data set, see below). In both datasets, species unknown to children but identified by the authors (e.g., the Aye-aye) for which re-nomination

procedures would have been impossible to perform, were kept at the correct species level (e.g., the Aye-aye thus becomes the unknown species x). Statistical estimates of species richness and shared species were performed on both raw and taxonomically adjusted datasets (see results). Statistical analyses (contingency tables) were performed with Statistica 7.1.

RESULTS

Sampling of "protectable" species

We collected approximately the same number of species both through the children's answers to the open questions (N=166 species, from 1151 names cited, Fig 1b) and with internet (N=184 species, from 1185 images, Fig. 1a). This was especially true when the taxonomic knowledge of the children was taken into account (taxonomically adjusted species names, see above; N=144 species for internet and N=144 species cited by the children, Fig 1c & 1d).

Overall, the richness estimator for both type of taxonomic precision plateaued after a sample size of ~180 for the internet sample and ~250 for the schoolchildren (Fig 1), indicating that our sampling was adequate to quantify "protectable" species diversity, as well as to compare the similarity of species diversity between both surveys ([47], see below).

Similarity between internet and schoolchildren

The diversity of "protectable" species was broadly similar between internet and schoolchildren samples. Focusing on the raw data (i.e., not taxonomically adjusted), although over a total of 256 different species only 92 were in common; these frequently cited species actually represented 80.5% of the samples. As a consequence, the computed Morisita-Horn similarity index was 0.663; indicating a broad similarity between internet and schoolchildren samples [48, 49].

This similarity index was higher when the taxonomic knowledge of the schoolchildren was taken into account (taxonomically adjusted species names, see above): of the 202 "species", 84 were common between both samples, which

represented 86.9% of the samples, leading to a relatively high Morisita-Horn index of 0.713 [48, 49].

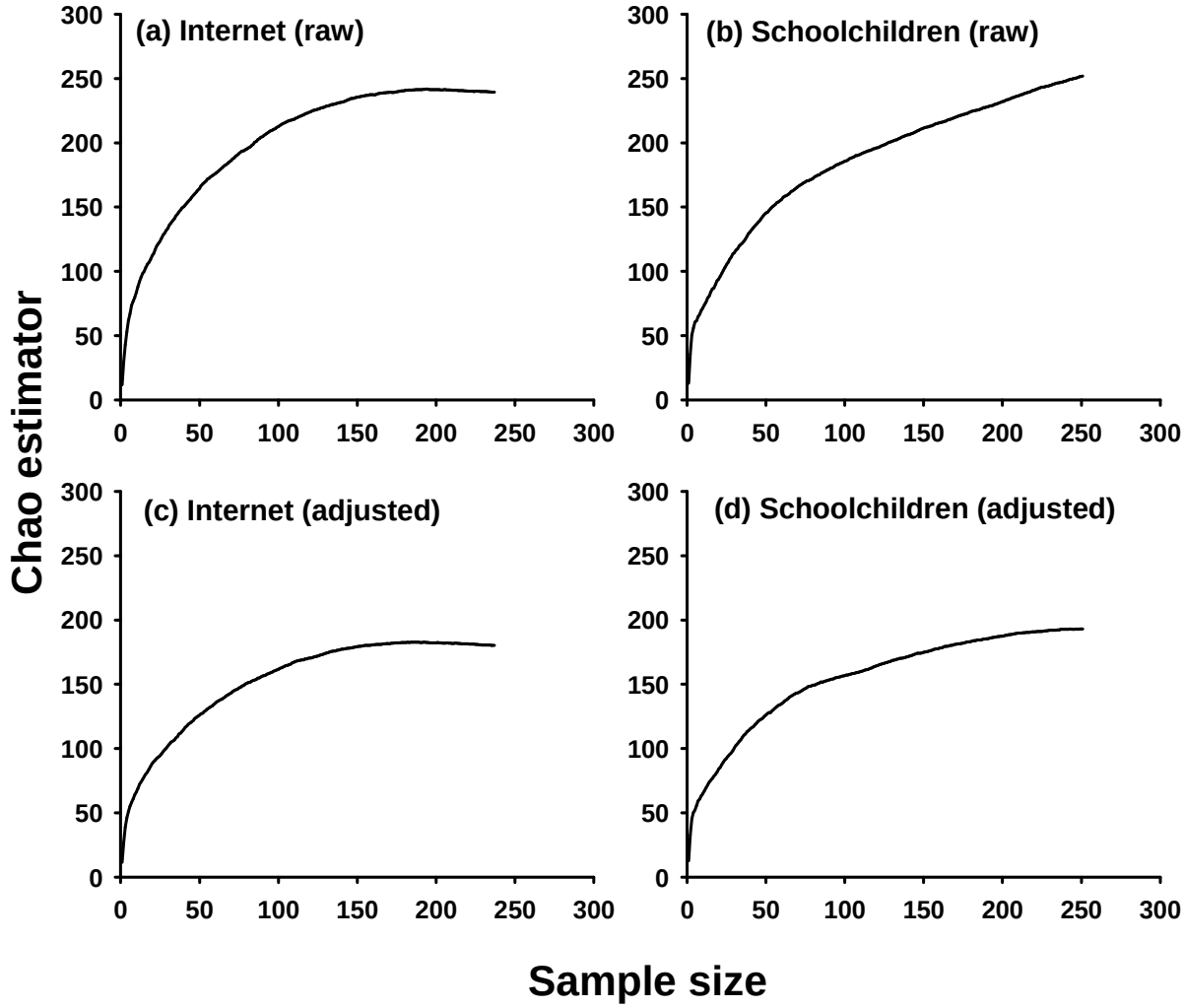

Figure 1. Sampling of "protectable" animal species. The adequacy of sampling was based on richness estimator (Chao estimator) for internet (raw and adjusted, N=236 samples; see text for details) and schoolchildren (raw and adjusted, N= 250 samples; see text for details). All the curves reached a plateau, indicating that we adequately sampled the diversity of "protectable" animal species both for internet and for schoolchildren.

Perception of local versus exotic species

Observed species

Overall, schoolchildren declared to have observed in person 61.1% of the species displayed on the colour plates. As expected, local species were observed more often than exotic species (χ^2=517.17, df=1, p<0.0001; 74.7% of local species already

observed *versus* 47.6% of exotic species, Fig. 2). A closer inspection of the data showed that the relatively high proportion of exotic species seen in person was explained by the fact that many cited species (elephants, lions…) were observed in zoos. More precisely, such exotic animals were observed both virtually in the media, essentially television (53.8%), but also in person in zoos (50.8%). Only a very low proportion of children declared having already observed exotic species in their local environment (3.5%, possibly during a trip in a foreign country). These results revealed a great level of honesty and understanding of the children, thereby strengthening the reliability of the answers.

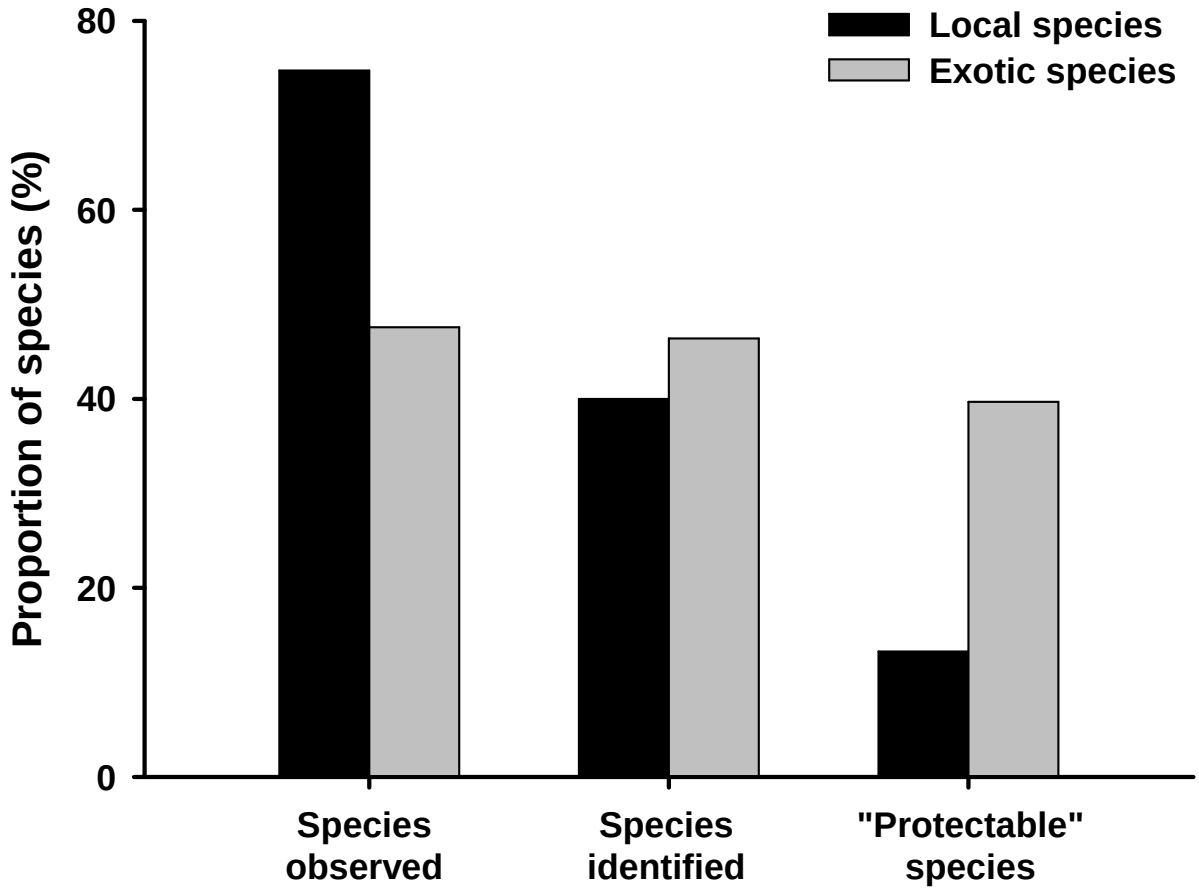

Figure 2. Local vs. exotic biodiversity. Proportion of exotic (grey bars) and local (black bars) species for which live specimens have been seen/observed by schoolchildren ("Species observed"), that were successfully identified by schoolchildren ("Species identified") and that were perceived as "protectable" by schoolchildren ("Protectable species"). See text for details.

Identification of pictured animals

Overall, schoolchildren were able to identify 43.1% of the species displayed on the pictures at a relatively precise taxonomic level (e.g., a "Bald Eagle" identified at least as an "Eagle" rather than as a "Bird").

We detected a difference in the identification rates between the local and exotic species displayed on the pictures with the local species being less often identified than exotic ones (χ^2=33.62, df=1, p<0.001; 39.9% of local species *versus* 46.4% of exotic species identified to a correct taxonomic level, Fig. 2).

Willingness to protect

Overall, the mean "protectability" level (animals selected by the children) of the species displayed on the pictures was of 23.2% (range 2% - 73.2% depending upon the species). Schoolchildren were more prone to protect exotic rather than local species (χ^2=671.62, df=1, p<0.0001; 39.7% of the species rated "protectable" were exotic, whereas only 13.3% were local species, Fig. 2).

Most of the "protectable" species were highly iconic and exotic species: the Giant Panda and the Polar Bear (respectively 73.2% and 71.1%). The less often identified species (the Green Rose Chafer, not recognised even at a broad taxonomic level) is a common and conspicuous (brightly coloured) local insect species rated as "protectable" by two schoolchildren solely.

DISCUSSION

We emphasize that our aim was not to investigate to what extent children were able to correctly cite animals according to official classifications clearly intended to professional conservationists and managers rather than designed for environmental education of young children (e.g. IUCN red list). Instead, we focused on the children willingness to protect certain animals; a key issue for a long term perspective. Our results revealed strong and worrying bias: the biodiversity of species that should benefit from protection is meagre, and more worrying, essentially driven to the narrow messages broadcasted by media. This means that most of the biodiversity is

neglected, and that children are not fully aware that conservation actions at a local scale are of fundamental importance.

The generalization of our results to other countries could be a limitation to our study. For instance, the spontaneous biodiversity of protectable species might be greater for children from other countries. If so, compared to the French children, those from other geographic areas may well have more open and more comprehensive view of the biodiversity crisis. Unfortunately this is not the case. We performed similar surveys in Europe (Italia, Serbia, Slovakia, Spain, and Portugal, N=1107), Africa (Morroco, N=250) and Asia (Nepal and Turkey, N=483). The similarly between the species spontaneously listed by non-French (N=1840) *versus* French children (N=647) was very high (Morisita-Horn similarity index = 0.751). Whatever the country, children essentially refer to few iconic mammals, suggesting a strong influence of media. We also performed Internet surveys (as exposed above) using English, Spanish or Italian. The main outcome is that whatever the language used, the same few iconic species occupy most of the space (comparing non-French *versus* French surveys; Morisita-Horn similarity index = 0.905). In fact, the similarly between the list of species that dominated the responses was even stronger through media comparison rather than with the children; a result somehow expected given the homogeneity of the animal conservation messages (big cats, bears, dolphins and whale plus few other icons clearly dominate). Below we examine in more details the relationship between media and children, along with potential consequences in terms of environmental education.

Both the internet and the schoolchildren surveys enabled us to identify ~150 "protectable" animal species (see results). A superficial examination of this result could be interpreted as an encouraging message in terms of conservation of biodiversity. A far more pessimistic view is conceivable however. Pooling schoolchildren and internet, only 256 different "protectable" species were counted, representing less than 3% of all threatened animal species listed by the IUCN, 4% of all threatened vertebrates (both values strongly underestimate the actual numbers of threatened species; IUCN 2010). Clearly, most of the animal species are neglected due to the preference for very few charismatic icons. This contrasts with the fact that children have tremendous capacity for learning creature identity and characteristics.

Young children are able to recognize every single specimen of the 493 Pokémon "species" (e.g., a value three times greater than our "protectable" species number) but they face great difficulties when asked to recognize common animal species [18]. Although, our estimate of "protectable" species richness provided by media was limited to the internet and by our approach, our results suggest that major media focused information on few iconic and exotic species. This is particularly problematic because the internet is currently one of the main sources of information [25-28, 30, 31].

Various media sources have a strong impact on the development of human's attitudes toward wildlife [34]. Accordingly, we detected a strong similarity in the patterns of "protectable" species obtained from the internet search and from the written questionnaires administered to the children. Internet (or other media such as television assuming that they also broadcast narrowly-focused messages on few iconic species) appears to be one of the main channels used by children to gather information on biodiversity conservation issues (either directly, or indirectly through parents, teachers, educators, etc.). Media are focused on a few charismatic and flagship species [35] which are consequently predominant among the species cited by school children (e.g., the giant panda or the polar bear, see results). Because of their natural attractiveness, flagship species are used as conservation tools to raise conservation awareness and funding. However, it has been shown that focusing too heavily on these species detracts conservation efforts from other species and projects [35, 50, 51]. In fact, several studies even suggested that the information provided by media has currently no direct value for the conservation and protection of large groups of charismatic fauna [52]. We do not adopt such a pessimistic view and we nonetheless consider that media have the virtue to raise an ecological awareness, and hence that they are useful. But we also emphasize that there is also a taxonomic bias in orienting exclusively the general public to protect not-threatened species to the detriment of the general biodiversity (e.g., domestic cats and dogs were among the most cited "protectable" species, unpublished data).

Disregarding the potential negative effects of the media focusing too narrowly on very few species, our most worrying result is the meagreness of the knowledge of the children regarding very common local species. The constrained survey showed

that children indeed observed local animal biodiversity (75% of the local species presented on the colour plates). However, exotic species were more easily identified than local ones. For instance, the toucan (exotic for French children) was recognized by 41% of the children, whereas the European black bird (a very common and conspicuous species in our study area) was recognized by only 21% of the children, and some common insects (e.g., house centipedes) or amphibians (e.g., newts) were virtually never identified. Clearly, knowledge of local animals is dramatically thin [19, 53]. This result supports the grave and deleterious disconnection between people and their local environment documented by other researchers [29]. There are two concerns associated with this issue. Firstly, people care only about what they know [18, 32]. Secondly, and probably more importantly, schoolchildren may well be more prone to protect exotic and hence somehow "virtual" biodiversity rather than their own local species (see Figure 3 for the relationship between "protectability" and "virtuality" of the species displayed on the colour plates). For instance, this can typically explain the paradoxical abuses of pesticides in the gardens of people that consider themselves as concerned by the decline of tigers. A widespread referral to virtual nature or virtual biodiversity, combined with the extinction of vicarious experiences tends to devalue local environment by substituting essential direct and emotional experiences of local natural areas by virtual ones [40, 42].

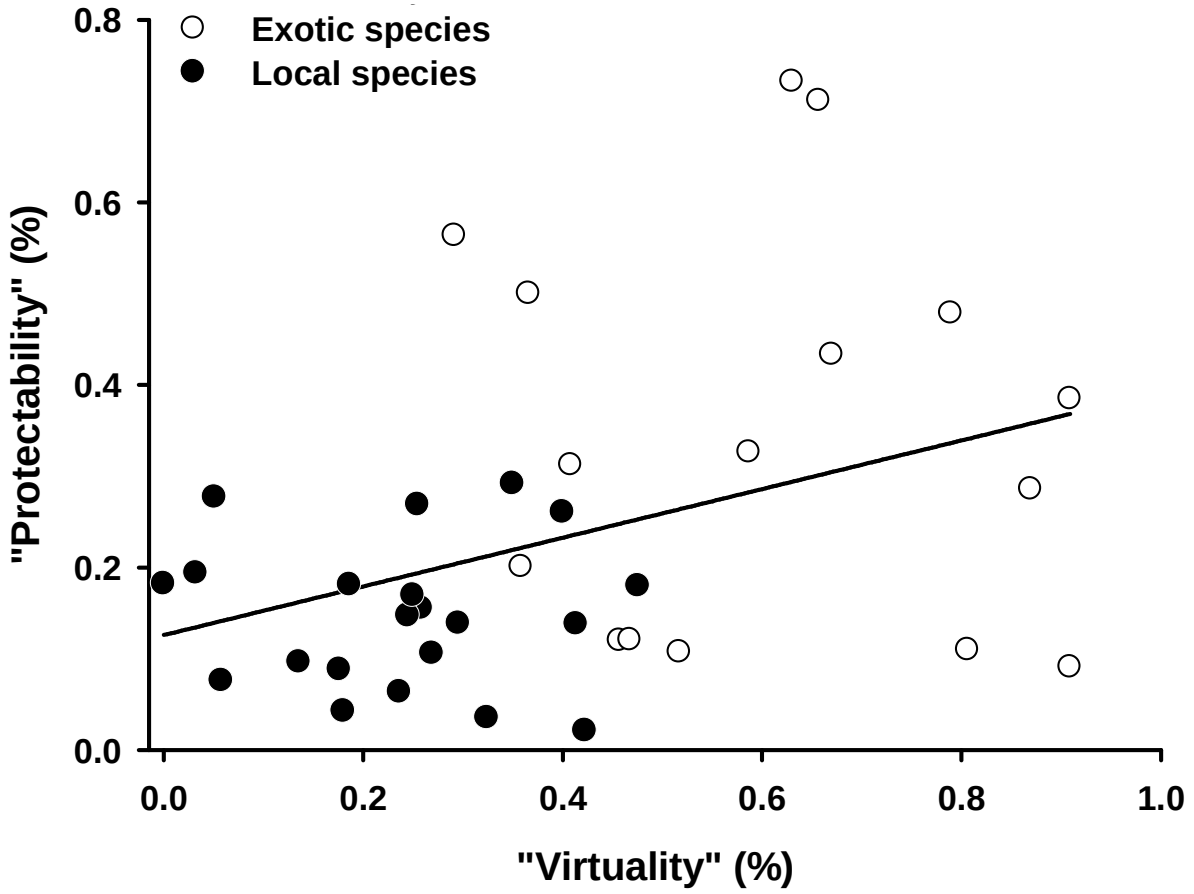

Figure 3. Relationship between "virtuality" and "protectability". "Virtuality" is given as a proportion, from 0 for species for which live specimens have already been seen/observed by all of the interviewed schoolchildren, to 1 for species that have never been seen/observed. "Protectability" is given as a proportion, from 0 for the species that are not declared as "protectable" by schoolchildren to 1 for the species rated as protectable by all the interviewed schoolchildren. Exotic and local species are represented by open and filled circles respectively. The equation for the regression line is $y=0.126+0.266x$ ($F_{1,36}=5.52$, $p=0.02$).

The poor knowledge and low willingness to protect local species we detected is problematic and most worrying. Indeed, all studies on these issues converge on the fact that to be effective, conservation awareness must be heavily based on the local biodiversity, on the species from our own backyards and gardens [32, 54, 55]. Knowledge of the most common local organisms is crucial: in practice, most individuals have far greater opportunities to efficiently protect local biodiversity rather than to protect exotic species (e.g., signing a petition). In this respect, both media and environmental education (notably at school) have key roles to play.

Schools are crucial for the creation of positive attitudes toward global biodiversity and are even expected to compensate for what parents ought to do [56]. There is currently a strong disparity however between what should be and what is done [57]. Environmental education mediated by local experiences is declared as a key component in academic programs, but practical actions are not encouraged [4, 58]. Very little time (if any) is spent on direct observations of plants and animals; field experiences have declined considerably over time [29, 38, 54, 59]. This is particularly regrettable because even school playgrounds, and not necessary wild forests, are extremely valuable settings for investigations in nature both in urban and rural areas [19]. The use of such anthropized sites engage little or no travel costs, little time; and could be used in long-term projects (e.g., a simple monitoring of snail populations would be costless, fascinating and rewarding for the schoolchildren). Learning about animals in their natural habitats may result in higher knowledge scores than would any lessons in school [19].

Both media and schools have the responsibility to engage children in developing favourable attitudes toward biodiversity. In the current context of strong biodiversity decline, the successful alarming of people and children with a few charismatic animals, although important, is clearly insufficient. Natural attractiveness toward animals must be also developed toward common and local organisms by engaging children with practical experiences with nature. Our study simply adds another call to push the children outside and away from the screens.

Acknowledgments

We thank Dr. M. Place for his help to set up the questionnaire, and the teachers and children involved that kindly participated in this study. We thank Rastko Ajtic, José Brito, Jelka Crnobrnja-Isailovic, El Hassan ElMouden, Mehmed Erdogan, Monica Feriche, Juan M. Pleguezuelos, Pavol Prokop, Aida Sánchez, Xavier Santos, Tahar Slimani, Bogoljub Sterijovski, Lijiljana Tomovic, Muhammet Uşak and Marco Zuffi for questioning children in their respective residential countries. We thank Stephen J. Mullin for usefull comments to improve the manuscript. R. Cambag provided assistance in printing of the colour plates

Author contributions

Conceived and designed the study: J-MB, XB. Gathered the data: J-MB, XB, FB. Analyzed the data: J-MB, FB, XB. Wrote the paper: J-MB, XB, FB.

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4.2 Evaluation des attitudes des enfants envers les serpents, et sortie de terrain.

4.2.1 Résumé du chapitre

L'objectif de ce chapitre est double : 1) évaluer la pertinence des sorties sur le terrain, 2) tester des moyens pratiques pour la conservation des serpents.

Au préalable, il a semblé judicieux de sonder les attitudes préexistantes des enfants vis à vis des serpents (Article 3). La large majorité des messages qui concernent les serpents, et la presque totalité des études réalisées sur la perception des serpents par l'homme sont fondées sur l'idée que les serpents génèrent une peur innée, des phobies et une aversion. Ces idées paraissent tellement solidement ancrées que pour certains auteurs d'études scientifiques (et donc aussi pour les éditeurs et relecteurs impliqués) elles seraient inscrites dans nos gènes. Face à la diversité des cultures humaines et de leur relation à l'environnement ces messages paraissent pourtant très simplistes. Malheureusement, rares sont les études qui font état des attitudes à une large échelle et sans tomber dans le biais systématique de tout expliquer à la lueur de terreurs ancestrales (la plupart des gens, chercheurs y compris sont en effet effrayés par les serpents, ils y perdent leur objectivité). Nous avons donc tenté de pallier ce manquement en dressant un état des lieux de la perception des écoliers vis-à-vis des serpents dans dix pays différents en évitant l'erreur classique de leur demander s'ils préfèrent les lapins aux serpents. Nous avons tout d'abord eu la plaisante surprise de voir que les serpents sont loin d'être détestés par tous les enfants, ils suscitent plutôt le respect et assez régulièrement la sympathie contrairement à la plupart des adultes. Dans les pays en voie de développement, tels que le Népal et le Maroc, l'aversion des serpents est plus prononcée, ce qui se justifie amplement par le danger qu'ils représentent. Dans les pays occidentaux, les enfants associent principalement leur aversion à une peur et à des images irrationnelles, transmises de génération en génération. De façon intéressante, nous avons observé

une corrélation entre le degré de richesse d'un pays (PIB) et le niveau moyen d'aversion des enfants (Figure 1). Bien que l'investigation mérite d'être poussée, l'aversion des serpents est induite par la peur qui pourrait être associée au manque d'éducation et à l'accès aux soins en cas de morsure dans les pays en voie de développement.

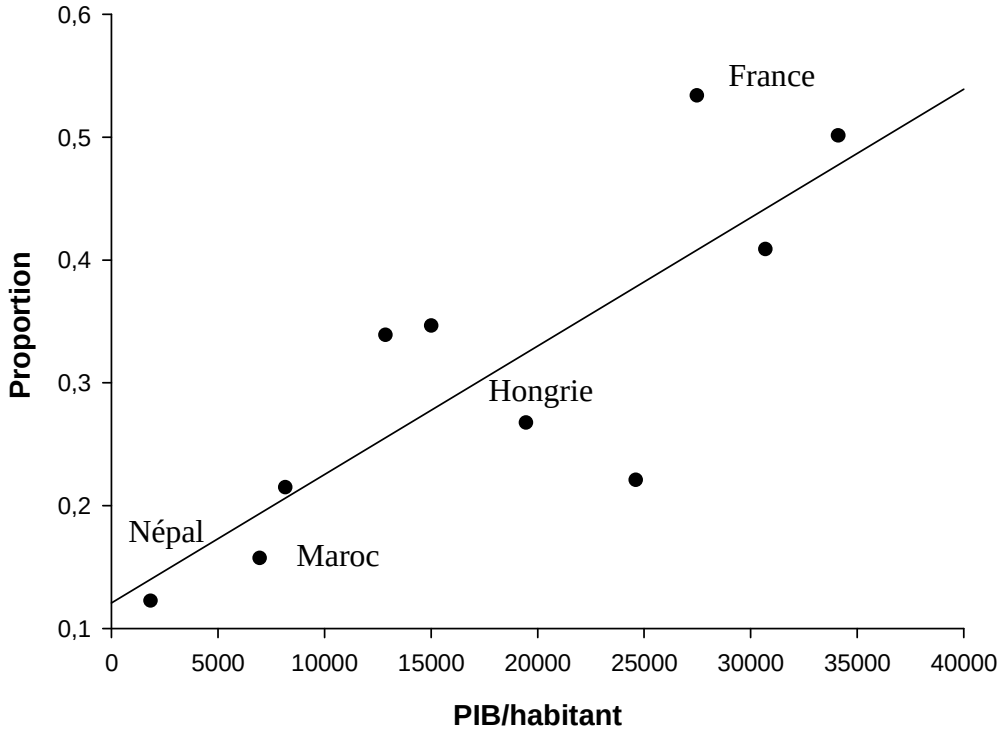

Figure 1 : Relation entre le Produit Intérieur Brut (PIB) par habitant et la proportion d'enfants qui déclarent aimer les serpents dans les dix pays enquêtés (r = 0.8159, p = 0.004).

Figure 1: *Relationship between the Gross Domestic Product (PIB) per habitant and the proportion of children that declare to like snake in the ten countries surveyed (r = 0.8159, p = 0.004).*

De façon inattendue, les enfants pour la grande majorité, désirent protéger les serpents et surtout expriment rarement des comportements de destruction à leur égard. Ces résultats sont très encourageants car il ne semble pas difficile de convaincre les enfants de protéger des espèces soient disant impopulaires, et le reflexe typique des adultes « peur égale destruction » ne pollue pas encore les esprits

des enfants. Il est donc d'autant plus important de ne pas limiter les actions d'éducation aux espèces charismatiques.

L'expérience de terrain est certainement la seule méthode capable d'intéresser les enfants aux espèces locales, situées sur le pas de leur porte, ou du moins la plus efficace. Nos analyses montrent que les enfants qui ont eut une expérience avec les serpents (voir, toucher) les aiment plus que ceux qui n'en ont jamais touché, mais la manipulation est cruciale (Figure 2). Ce résultat est capital, il démontre qu'il ne faut pas favoriser l'approche intellectuelle et virtuelle mais au contraire qu'il faut privilégier l'approche émotionnelle et pratique. Comme les serpents supportent très bien les manipulations, et puisque les enfants font très attention lorsqu'ils sont bien encadrés, ce type de projet est facile à mettre en œuvre.

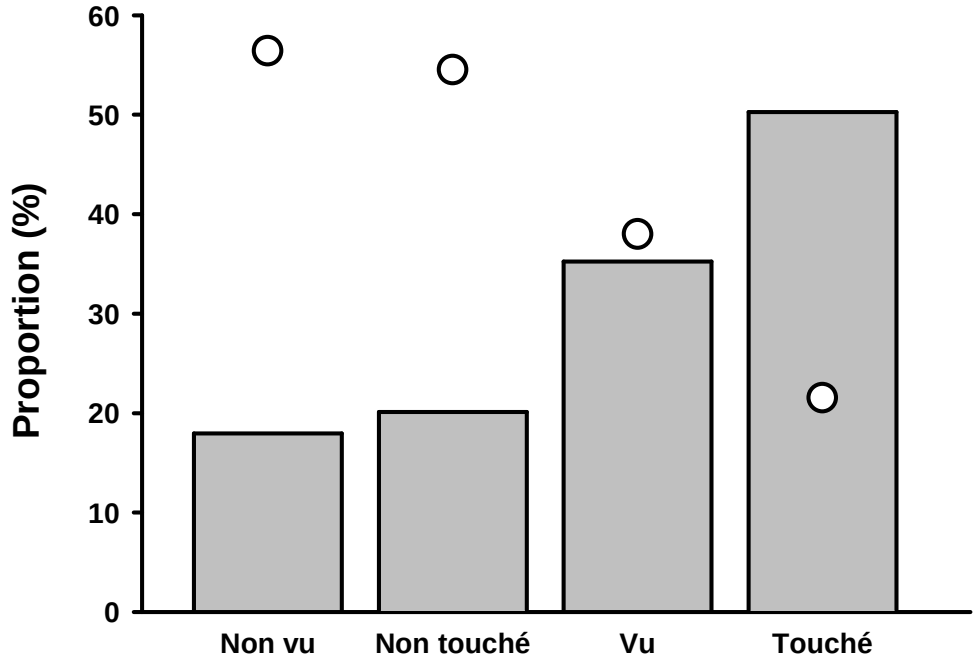

Figure 2 : L'analyse d'un sondage réalisé sur environ 1500 élèves (8-12ans) montre une aversion vis à vis des serpents (cercles blancs = n'aime pas) supérieure à l'affection (barres grises = aime) chez les enfants qui n'ont jamais vu ou jamais touché de serpent. Les attitudes s'équilibrent chez les enfants qui ont vu des serpents. La plupart des enfants qui ont touché des serpents les aiment.

Figure 2: *Survey on 1500 pupils (8 to 12 years old) show that aversion toward snake (white dots) is higher than likeability (grey bars) on pupils who had never seen or touched a snake. Attitudes are bringing into balance on pupils who had seen snake. Most of the pupils who had touched snakes like them.*

Nous avons aussi testé, l'effet d'une expérience de terrain sur le changement des perceptions des enfants envers les serpents (Article 4). Contrairement aux idées reçues, cette action n'a représenté aucune difficulté et au contraire à largement suscité l'engouement à la fois des élèves et des enseignants. Les enquêtes ont permis de mesurer un basculement significatif des attitudes des enfants vis-à-vis des serpents. Les changements se sont principalement opérés grâce au canal affectif développé probablement grâce à une expérience favorisant le contact physique associé à la découverte de l'histoire naturelle des animaux. Par exemple la palpation de femelles gravides permet de sentir les œufs. Suite aux sorties, les enfants sont à même de protéger les serpents au même titre que des espèces charismatiques et aimées comme le panda. Bien que, cette action mérite d'être évaluée sur le long terme, son efficacité sur le court terme montre que les expériences de terrain sont des moyens formidables pour sensibiliser les enfants à l'environnement local et augmenter le spectre des animaux à aimer et protéger. De telles actions sont également des moyens concrets pour sensibiliser les citoyens à la préservation des serpents.

4.2.2 Perceptions des serpents par les enfants (Article 3)

JMB

Running head: children and snakes

Schoolchildren and one of the most unpopular animals: are they ready to protect snakes?

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Word count: 6792

Abstract

For cultural reasons and narrow scope of environmental policy makers, most conservation actions focus on few charismatic animals and consequently neglect the majority of the remaining organisms; many unpopular species are even killed in huge numbers with little concerns. Redressing such bias is essential, notably through educational programs. Snakes are unpopular animals, they suffer from human harassment in many places, and they show population declines worldwide. Snakes are therefore suitable candidates to better educate schoolchildren. Responses to a questionnaire administered to 2,570 schoolchildren (7-14 years old) from 10 countries showed that many children liked snakes and that most of the students wanted to see snakes protected. Such counterintuitive results were supported by the fact that schoolchildren explained clearly why they liked snakes or disliked snakes. Previous physical contact with snakes was associated with snake likeability. We found strong expected differences between countries: When venomous snakes represent a health burden, most children declared themselves to be afraid. Overall, our results negate the simplistic and previously unverified typical adult view that snakes are necessarily perceived as frightening animals, thereby justifying the persecution. This study provided an encouraging message suggesting that is not compulsory to focus on charismatic animals to convince children to protect wildlife.

Key words: Environmental education, conservation, snake, attitudes, international survey, willingness to protect.

INTRODUCTION

People express various, complex, and sometimes contradictory or irrational attitudes toward organisms (Tisdell and Xiang 1998). For instance, a charismatic species like the Indian elephant can be perceived as a pest, a valuable resource, and/or a loveable animal (Swanagan 2000; Bandara and Tisdell 2003; Lindemann-Mathies 2005). As expected, there is strong positive association between the levels of likeability for a species and conservation concerns, which in turn, affects the incidence of practical actions to the species and its required habitats. (Tisdell et al. 2006; Wilson and Tisdell 2005; Martín-López et al. 2007). The attitude of people, both general public and locals, is a strong determinant for conservation policies and is of prime importance to investigate how threatened animal species are perceived (Reiter et al. 1999).

A relative, few species benefit from a strong popularity level: mammals and birds attract far more support and funding than the far more diverse array of invertebrates for instance (Clark and May 2002; Tisdell et al. 2005). Although iconic species have a strategic role to help in collecting funds, an exclusive focus on charismatic organisms can also have a negative impact to reach general conservation objectives (Williams et al. 2000; Stokes 2007). Indeed, resources for conservation are limited, the conservation of the biodiversity suffers from a strong negative taxonomic bias, and some organisms are consequently neglected in conservation programs (Clark and May 2002; Seddon et al. 2005; Marešová and Frynta 2007). Pairwise comparisons of children attitudes showed that predators, pests and disease-relevant animals are generally perceived more negatively than other animals (Prokop and Tunnicliffe 2008, 2010). Education oriented toward non-popular species which can contribute in redressing such taxonomic bias, is needed (Feinsinger 1987; Kellert 1993). Because schoolchildren are far more receptive than adults, they should be one of the main targets to conduct efficient educational programs (Jacobson and McDuff 1998; Feinsinger 1987).

In practice, despite the importance of each form of life, the current number of iconic species is limited and likely incapable of providing an indirect protection for most of the rest of the wildlife through an umbrella mechanism. Furthermore, many species are unappreciated or hated, and the existence of concurrent endearing species is likely of little help to them. For example, invertebrates are mostly associated with

fear, antipathy and aversion (Kellert 1993) but the growing popularity of polar bears does not change such negative misperception. Ideally, to encompass a wide biological diversity and to redress deleterious taxonomic bias, it is essential to convince peoples about the value of the diversity of organisms, and thus to focus on those species that people do not like (Kellert 1993, 1996). Indeed, it is meaningless to convince someone to love something he already loves. Snake are among the best candidates in such endeavour. First, they are among the least popular animals, they suffer from a negative image, fear and phobia being the most common attitude of people toward them, and they are killed or tormented in huge numbers in many countries (Morris and Morris 1965; Seshadri 1984; Shalev and Ben Mordehai 1996; Gomez et al. 2004; Christoffel 2007; Prokop et al. 2009; Yorek 2009). Second, snakes are facing a general decline (Reading et al. 2010). Thus, improving public opinion for snakes is not only essential in term of general attitude, but also in terms of wildlife conservation (Morgan and Gramann 1989; Kaplan 1997; Gomez et al. 2004; Mullin and Seigel 2009).

Several studies attempted to explain the origin of such widespread and strong negative perceptions. It was been notably argued that the prevalence of snake fear in humans is a result of the heritage of evolutionary history: the fear of snakes being deeply encoded into our genome (Öhman and Mineka 2003; Isbell 2006; Marešová et al. 2009). However, such notion that snakes are necessarily perceived as major threats (Öhman and Mineka 2003; Isbell 2006; Marešová et al. 2009) is simplistic and largely limited to recent occidental culture (Morris and Morris 1965). Snakes have been venerated over extremely prolonged time periods, are still major positive divinities in many cultures, or an important source of food in many places (Klemens and Thorbjarnarson 1995; Bonnet 2007). Although a wide diversity of situations exists, a survey of the relationships between human beings and snakes reveals that they are far more often associated with positive symbols (water, knowledge, eternity, fertility, health, etc.) than with negative symbols across human cultures and across time (Bonnet 2007). The recent domination of a limited number of cultures and beliefs, relayed by media, most likely explain the general negative attitude toward snake than a putative set of alleles. Fear is known to be strongly influenced by cultural reinforcement and generalized expectancies (Davey 1995).

Different situations affect social acceptance capacity or whether animals are considered worthy of protection. To plan environmental education programs focusing on snake conservation, it is essential to first examine attitudes towards these animals (Bjerke et al. 1998; Prokop et al. 2009) instead of relying on the unverified assumption that almost everyone is frightened and hates these animals because of a genetic predisposition.

Previous studies on this topic were biased on a postulate that snakes always generate fears, notably by scaling levels of unpopularity (Christoffel 2007; Prokop et al. 2009). Remarkably, almost no studies have investigated children's appreciation of snakes on a large scale (more than one country), and more surprisingly ignored the central question of biological knowledge about snakes (Burghart et al. 2009). Thus, some unexamined questions revolve around the relationship between perception and willingness to protect snakes.

We used a questionnaire to investigate the perception of snakes by schoolchildren (7-14 years old). We collected a total of 2,570 written questionnaires in 10 countries from 3 continents in order to encompass a wide diversity of geographical and cultural situations (Africa [1], Asia [2], and Europe [7]). The questionnaire included both close and open questions. We focused on basic attitudes of pupils such as likeability, fear and willingness to protect snakes, but we also investigated the knowledge of snake biology. We notably addressed 4 main questions:

- What are the proportions of children who like, or dislike, snakes?
- What are the broad correlates of snake (dis)-likeability?
- What is the level of biological knowledge of schoolchildren about snakes?
- Is there a relationship between the perception of schoolchildren of snakes and their willingness to protect (or kill) them?

MATERIAL AND METHODS

Questionnaire survey

The survey was performed in 10 countries in 2008-2009 (Table 1). We developed a questionnaire based on preliminary tests (Ballouard 2005) and under the supervision

of a committee that included one teacher specialized on child psychology. The questionnaire was translated into nine different languages and was checked by primary school teachers in each country. The survey was performed following precise written instructions in 2007, 2008 and 2009. Using the network of collaborators (see authors list), 96 classes were selected both in urban (city >30,000 inhabitants) and rural schools (village <2,000 inhabitants). The methodology of the questionnaire survey was presented in preliminary methodological study showing the children's answers to be reliable (unpublished data). For the current study, we focused on a subset of items precisely related to snakes. We were notably interested by the following issues:

* Broad perception of snakes: we asked the children if they liked, or disliked snakes. Then, the children had to briefly explain why.
* Influence of previous experience with snakes: we asked the children if they had ever seen or handled a snake.
* Taxonomic knowledge: we asked the children to list all the species they knew.
* Willingness to protect snakes: we asked the children if they considered necessary to protect snakes.
* Behaviour when facing a snake: we asked the children if they would kill a snake in case of an encounter, and then to explain their decision.

Table 1: numbers of schoolchildren questioned in the ten countries sampled, some children did not indicated their gender.

Country	**Gender**		
	F	M	NA
France	227	270	59
Hungary	142	128	2
Italy	45	53	
Morocco	127	115	15
Nepal	10	22	9
Portugal	27	32	
Serbia	163	132	
Slovakia	80	79	1
Spain	225	286	2
Turkey	153	178	6

A number of questions were closed (e.g., "Do you like snakes?"), and generated closed concise answers (e.g., "Yes", "No", or "It depends"). Other questions were open (e.g., "Why do you like, or dislike, snakes?") and sometimes generated longer complex answers. Consequently, to perform the analyses we classified such complex responses into the six broad categories.

1. Affective: children clearly introduced an affective factor. For instance using terms such as "Because they are cute".
2. Aspect and behaviour: the physical aspects of the snakes were predominant. Words related to colour, size, feel (temperature, sliminess…), and behaviour (crawling…) were the criteria retained.
3. Dangerousness: this category was established on the use of terms such as "They are venomous", "Dangerous", "They can bite".
4. Fear: terms such as "I am afraid", or" I panic" were retained in this category.
5. Naturalistic: children employed terms related to the importance of the snakes for science or ecosystems; for instance "They are interesting", "They are useful".
6. Others: this category includes some answers not easily classified using the criteria above, or belonging to other poorly represented categories (e.g. patrimonial, moralistic…). For example answers such as "It is not a pet", "I don't know", "Because animals are vanishing", "They are living animals" were pooled into this category.

For the responses about biological knowledge, snake species named by the children were classified into broad 3 taxonomic levels: 1- Species (e.g., King cobra), 2- Genus or family (e.g., cobra), 3- Larger groups (e.g., water snakes). We faced several difficulties to classify some responses: for example the French name "couleuvre à collier" which equals "grass snake" in English designates a species in French (*Natrix natrix*) but a wide group of species in English; the French equivalent for "grass snakes" being then "couleuvres". In practice, taking into account *versus* ignoring such complications did not change our main results. Some responses that were

unreadable (N=22), wrong (e.g., Iguana, N=129), or too imprecise (e.g., long snakes, N=99) were excluded from this analysis.

Analyses

Data were analysed using multiple logistic regressions (Allison 1999). Initially, all the independent variables were included in the model. A final minimum adequate model was obtained by backward elimination of non-significant ($p > 0.05$) variables.

To analyse responses with two answer possibilities (e.g., "Yes" versus "No", or "I kill it" versus "I do not kill it") we used a binomial distribution for the dependent variable. To analyse responses with three answer possibilities (e.g. "Yes", "No", "it depends"), we used a logit link function for the dependent variable. Gender, age, country, experience with snake (see and touch), fear, likeability, or the fact that children declare their desire to protect snakes for example were all treated as the independent variables in the model. Because the age of the schoolchildren had no effect in all the tests performed, we do not further consider this parameter. Similarly, we did not include all available additional information to avoid over complex design of the analyses (e.g. both rural and urban school where not sampled in all countries; living place [house with a garden, apartment…]). A small proportion of the questionnaires (5%) were incompletely filled up, generating minor fluctuations in the sample sizes depending upon the question addressed. Computations were performed with SAS package 9.2.5 (32, SAS Institute 2004) and Statistica 7.1 (StatSoft).

RESULTS

Likeability for snakes

A total of 2,699 open answers enabled us to explore correlates of snake likeability.

A total of 949 children declared that they do like snakes, 961 declared that they dislike snakes, and 587 were undecided and typically declared "it depends". Multiple logistic regression analyses revealed that four parameters had a strong effect on the likeability of the children for snakes: fear, previous physical contact with snakes, gender and country (Table 2). As expected, closed analyses showed in each

country surveyed a positive correlation between children's fear of snakes and the probability that to declare an aversion against these reptiles (Fig. 1). We also observed huge inter-country variation in the proportion of children that declared to like snakes: from 12% in Nepal to 53% in Spain.

Table 1: Main effects of GLM analyses of variance for each question.

Dependent variable	source	Df	Wald Khi-2	P
Like	country	18	115.0641	<.0001
	sex	2	26.8781	<.0001
	touch	2	54.9471	<.0001
	fear	2	123.2230	<.0001
Like? Yes Why	country	14	57.3256	<.0001
Fear	country	9	47.9458	<.0001
	sex	1	56.6723	<.0001
	touch	1	16.3008	<.0001
	country*touch	9	56.4848	<.0001
Protect	country	9	68.0939	<.0001
	touch	1	5.7893	0.0161
	fear	1	5.4452	0.0196
	like	2	42.0997	<.0001
Kill	country	9	154.1890	<.0001
	sex	1	9.2431	0.0024
	fear	1	14.5743	0.0001
	like	2	21.8289	<.0001

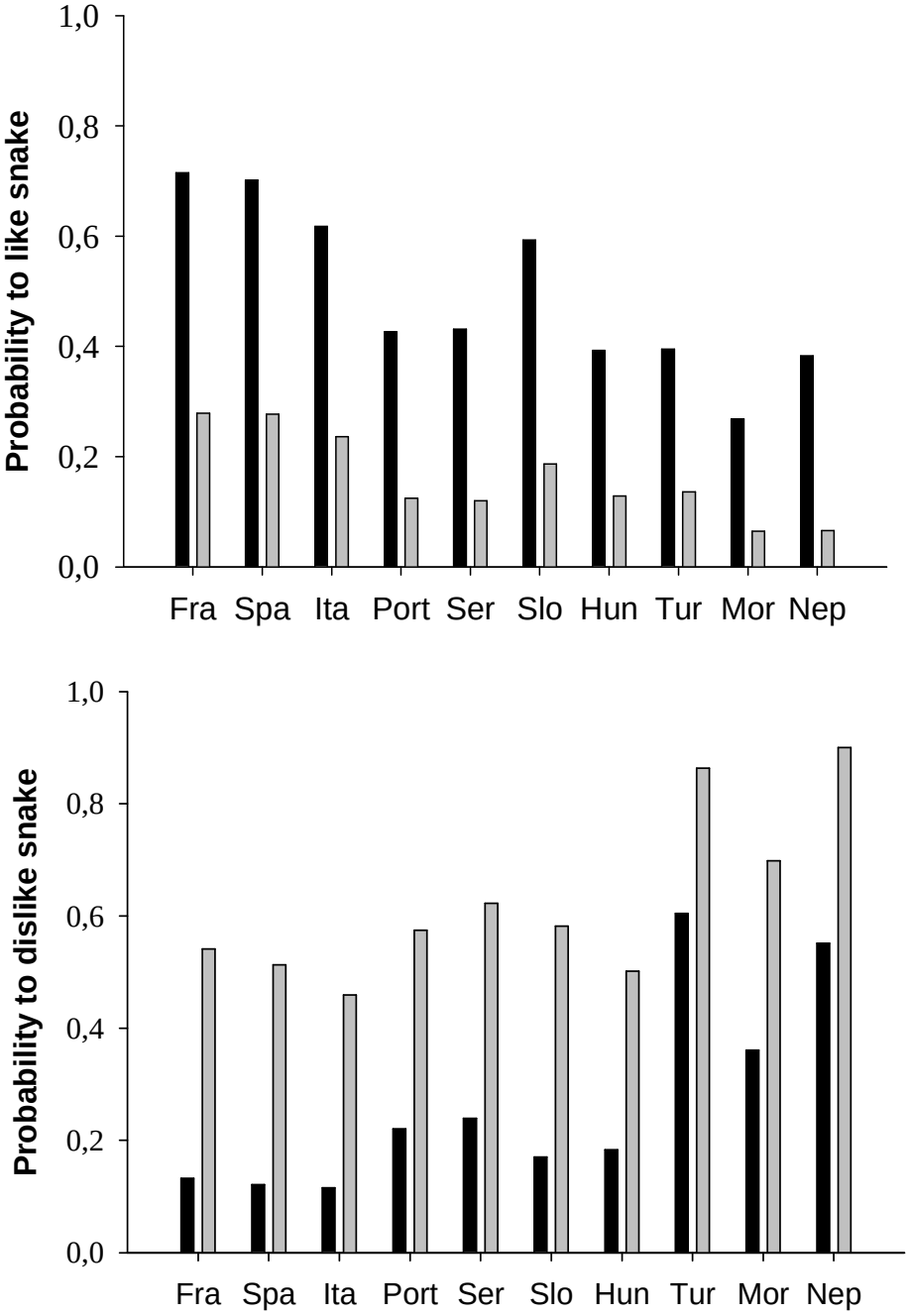

Figure 1: Probability that children declare to like snakes (N=949), or dislike snakes (N=961) in each countries surveyed (Fra = France; Spa = Spain; Ita = Italy; Por = Portugal; Ser = Serbia; Slo = Slovakia; Hun = Hungary; Tur = Turkey; Mor = Morocco; Nep = Nepal) according to the fact that they declare to have no fear of snake (black bars) or fear of snake (grey bars). Data for the 587 children that declared indecisive with respect to their likeability to snakes excluded. See the Results section for a multivariate analysis of these data.

Why do children dislike snakes?

None of the independent variables, or combination between them, produced an effect in the multiple logistic regression analyses we used to explain why children declared that they dislike snakes; similarly using the response "It depends" as a dependent variable. Thus no general pattern emerged from these analyses (Table 3). Broadly, children that declared to dislike snakes (N=961) associated such answer mainly with dangerousness (45.2% on average, ranging from 22% to 90% between countries), then with snake aspect (22% on average, 7%-39%), and fear 13% on average, 3%-29%). We observed an important variability between countries. Notably, dangerousness was prevalent in Nepal (90%), in Morocco (62%) and Turkey (52%). Fear was prevalent in occidental countries (ranging from 13% to 29%), but was rarely invocated in Nepal or Morocco (4% and 3%) for this question.

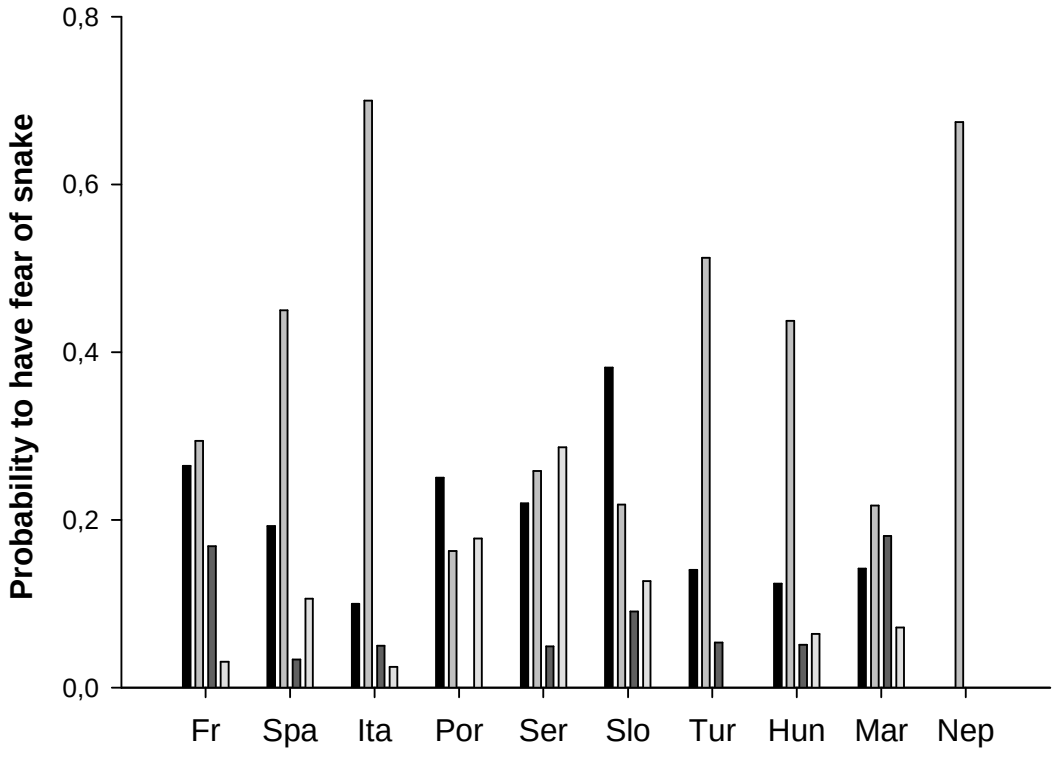

Figure 2: Probability that children explain there likeability (N=949) according to the following categorised raison: 1-Affectivity (black bars), 2-Snake aspect and behaviour (light grey bars), 3-danger (dark gray bars) and 4-naturalist interest (white bars), among all the countries surveyed (Fra = France; Spa = Spain; Ita = Italy; Por = Portugal; Ser = Serbia; Slo = Slovakia; Hun = Hungary; Tur = Turkey; Nep = Nepal; Mor = Morocco).

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Table 3: Proportion of the 6 categories (affectivity, danger, snake aspect and behaviour, fear, naturalistic and other) classified from the raison that children dislike snakes (N=961) in each country. In bold the proportion above 10%.

Reason	France	Italy	Spain	Portugal	Serbia	Slovakia	Hungary	Turkey	Morroco	Nepal
Danger	**41**	**33**	**43**	**38**	**49**	**22**	**28**	**52**	**62**	**90**
Affectivity	9	3	2	8	2	3	5	7	10	3
Aspect and behaviour	**23**	**37**	**21**	**21**	**30**	**43**	**39**	9	7	0
Fear	**13**	**13**	**29**	**25**	**15**	**15**	**20**	**16**	4	3
Naturalistic	0	0	1	0	0	0	0	0	1	0
Other	5	3	3	8	0	6	1	**15**	**17**	3

Correlates of children's fear of snakes

Previous physical contact, gender, and countries have an effect on the fact that children declared to be afraid or unafraid of snakes (Table 2). Fear of snakes was lower for children that had previously experience to handle a snake (Fig. 3). Girls systematically declared greater fear of snakes, even those who had a previous physical contact with them. However, great variations were observed among

countries: only 22% of the children declared to be afraid by snakes in Turkey, but 83% in Nepal. Interestingly, multiple logistic regressions suggested an interaction between countries and previous physical contact (Table 2). Children who never handled a snake in Slovakia, Hungary and Turkey expressed the lowest level of fear, whist the reverse was observed in France, Spain and Italy where previous handling was associated with a low level of fear.

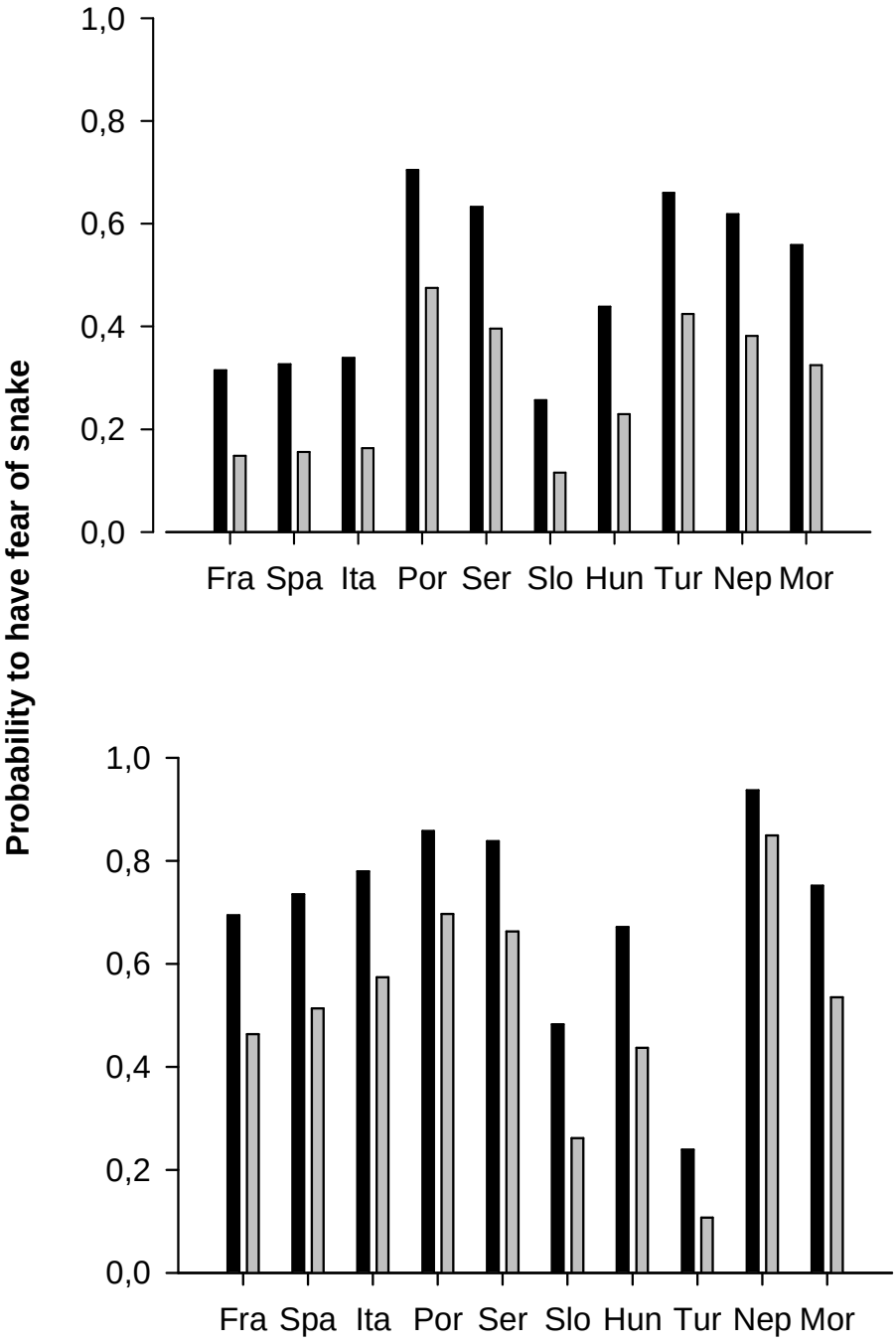

Figure 3: Probability that children declare to have fear of snakes in each countries surveyed (Fra = France; Spa = Spain; Ita = Italy; Por = Portugal; Ser = Serbia; Slo =

Slovakia; Hun = Hungary; Tur = Turkey; Nep = Nepal; Mor = Morocco) according to the gender: girls (black bars), boys (grey bars) and to previous experience with snake (touch).

Taxonomic knowledge

Most of the children were able to provide snake names at various taxonomic levels (only 226 children could not), and a total of 4,722 snake names was collected. After having removed unclear responses (e.g., mixing different species) we retained 4,487 snake names in the analyses. Disregarding taxonomic and zoological accuracy, 66 different types of snakes were cited. Few snake types (10 snakes), corresponding to the most popular snakes (e.g., cobras, vipers, boas…) represented more than 90% of the responses (Table 4), and only 21% of them were named at the species level (e.g., anaconda, king cobra, and nose-horned snake). Considering other snake types (10% of the responses), 32% were cited at a crude taxonomic level (e.g., family). Considering all the responses, 34 snake types were named at the species level, but most of them (22 [67%]) were cited less than 5 times. A significant proportion of the children (27%) cited snake types that do not occur in their country, and that they likely observed only through the media (e.g., anaconda). Overall, children exhibited a limited taxonomic and naturalistic knowledge about snakes.

Table 4: A list of the snakes most cited (more than 100 times) by children (all countries pooled, N=2,644 responses), with number of citations and their proportion.

Name	**Number**	%
Cobra	617	14
Viper	600	13
Anaconda	500	11
Python	479	11
Rattlesnake	559	12
"Colubrid"	345	8
King cobra	315	7
Boa	314	7
Grass snake	265	6
Nose horned snake	121	3

Willingness to protect snakes

In most countries, the proportion of children who believed in the importance of protecting snakes was high: ranging from 56% to 85%. In two countries, Nepal and Morocco, the majority of children considered that protecting snakes is not important: 59% and 63% respectively. The willingness to protect snakes was also influenced by likeability (as expected children that like snakes, along with undecided children, generally wanted to protect them); but interestingly, gender had no influence (Fig. 4).

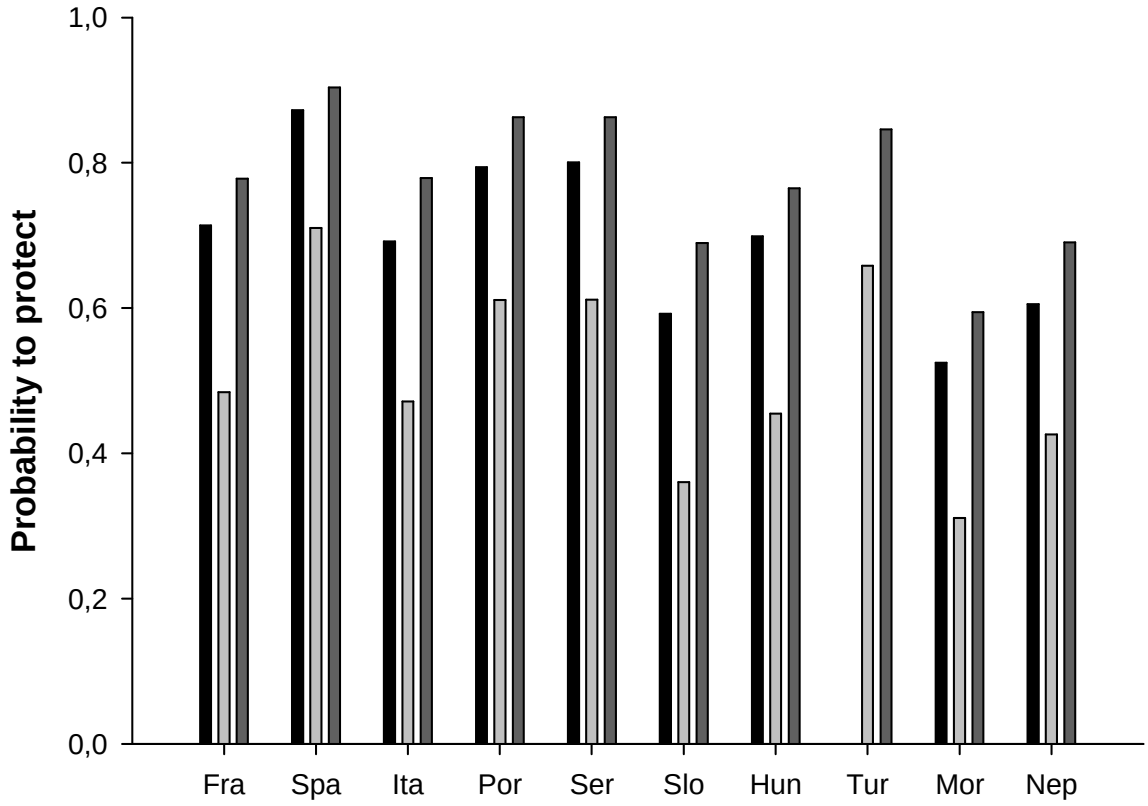

Figure 4: Probability that children declare that it is important to protect snakes in each country surveyed (Fra = France; Spa = Spain; Ita = Italy; Por = Portugal; Ser = Serbia; Slo = Slovakia; Hun = Hungary; Tur = Turkey; Nep = Nepal; Mor = Morocco) according to the fact that they declare to like snake (dark grey bars), dislike (grey bars) or indecisive (black bars).

Destructive behaviours

In six countries, the proportion of children that declared they would kill a snake in case of encounter was particularly low (ranging between 7% and 13%); such proportion remained relatively low in Turkey (29%). In three countries, the greatest number of children declared their intention to kill snakes: Morocco (45%), Portugal

(60%) and Slovakia (90%). Across countries, boys declared more often their intention to kill snakes compared to girls (Fig. 5). In all countries, fear of snake was associated with the propensity to kill them.

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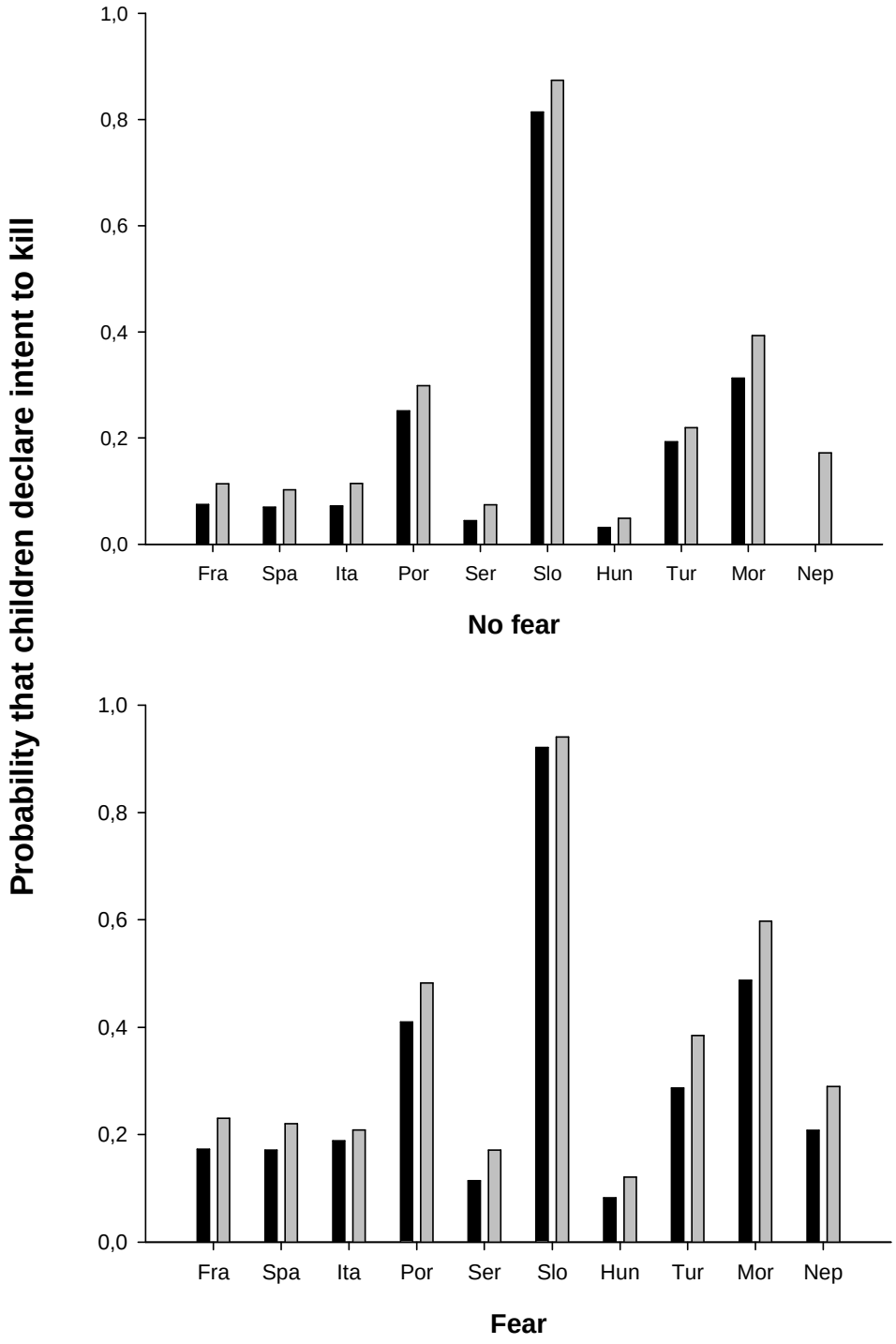

Figure 5: Probability that children declare an intent to kill snakes in each countries surveyed (Fra = France; Spa = Spain; Ita = Italy; Por = Portugal; Ser = Serbia; Slo = Slovakia; Hun = Hungary; Tur = Turkey; Nep = Nepal; Mor = Morocco) according to gender, girls (black bars) boys (grey bars) and the fact that they have fear of snake or not.

DISCUSSION

Gauging the likeability of children for animal species is important to assess the emotional relationship between them, and hence this provides an indirect, albeit crucial, factor to explore in order to better understand taxonomic bias in interest for wildlife (Czech et al 1998; Tisdell et al. 2006; Stokes 2007; Knight 2008). Broadly, we hypothesised that if children like an animal species, they will be prone to protect it; or at least, that a reduction of dis-likeability is important for educational and associated conservation purposes. Considering the recurrent opinion assuming that humans express a genetically coded fear of snakes, and consequently tend to hate them (Öhman and Mineka 2001; Öhman and Mineka 2003; Isbell 2006; Marešová et al. 2009), it is crucial to measure how children perceive such form of wildlife, and if fear for certain types of animals automatically translates into negative attitudes. Our results negate the simplistic and previously unverified view that snakes are generally perceived as frightening animals that should be destroyed. Instead we gathered a more positive, albeit complex, picture of children attitudes. In this study, we avoided to use comparison between snakes and charismatic animals (e.g., bears, cats) that automatically suggest that children and adults do not like snakes (Gomez et al., 2004). We emphasize that our investigation was more direct than previous ones in assessing how children perceive snakes *per se*, and not how they rank them in a biased list of animals (e.g. panda *versus* viper).

Do children like or dislike snakes?

Our results show that aversion against snakes among children is not obligatory. On average, 38% of the children declared that they do not like snakes, but 38% liked them, and 24% were undecided. In different countries, most of the children spontaneously declared that they like snakes, the opposite being observed in other countries (Fig. 1). In France for instance, only 25% of children declared to dislike snakes. Interestingly, half of adults questioned in France declare that they dislike snakes (N=112 adults questioned simultaneously to the children, age effect $P<0.01$, unpublished data). Such dissimilarity suggests a generation effect, likely because the main messages about wildlife shifted dramatically in the past decades: snake killing

was encouraged in the past (until the seventies), but the reverse applies now and children are educated to respect all forms of life in most countries (but not all). This also suggests that cultural factors are more important than putative genetic ones (see other results below). Whatever the explanation (further investigations are obviously required), the fact that only 38% of the children declared to not like the snakes was unexpected given the strong negative publicity spread against snakes in virtually all the media. Ignoring films and video games (where snakes equal evils and monsters), even wildlife documentaries present snakes as frightening killing machines.

Factors influencing snake likeability

Affective terms were often associated with the fact that the children liked snakes; physical aspect and behaviours of the snakes were key elements linked to such attitude. Because positive emotions, that are essential to get public support for species conservation (Knight 2008), can be conveyed by the above factors, it is important to redress the incorrect negative image of snakes largely spread through popular rumours and media (Brito et al. 2004). Most notably snakes are not cold, slimy, malicious, and most of them are harmless to humans. Of course, any attempt to redress the negative cascading impact of misperceiving snakes on conservation actions requires great caution in order to not diminish the prudence against dangerous species in countries where snakes contribute to health burdens (Kasturiratne et al. 2008). Interestingly, in occidental countries children often referred to incorrect attributes (slimness, coldness…) to justify their dislike toward snake, but this was not observed in African and Asian countries. This further suggests the crucial role of culture on attitudes toward snakes, and of the fact that children in the African and Asian countries we assessed have more contacts with snakes in the field compared to children from European countries.

Our results confirm that fear and dangerousness are key elements to explain why a number of children do not like snakes (Christoffel 2007). We found differences among countries, probably poly-factorial and cultural (Kellert and Westervelt 1984; Bjerke et al. 1998; Arrindel 2000; Kaltenborn et al., 2006). Likeability was higher in Western Europe (Spain, Italia, France) where venomous snakes cause much less health problems (Sharma et al. 2004; Kasturiratne et al. 2008); snake bite burden is

thus probably one of the key factors. Similarly, spiders are perceived more positively by students in areas with lower number of species that would be harmful to humans (Prokop et al. 2010). But we also observed that the aversion against snakes was not perfectly associated with the perception of danger. In countries where venomous snakes cause fatal accidents on a regular basis (Morocco, Nepal), snake aversion of children was mainly explained by perceived danger but rarely by fear. In occidental countries where the risk to get bitten is very low and the risk of fatality is virtually nonexistent, fear was nonetheless a major element. This suggests that fear can emerge independently from risk, but also that strong and persistent fear can be irrational and/or inspired by strong religious beliefs (Öhman and Mineka 2003). Although this later issue is probably important to better unravel the causes of people attitude toward snakes (e.g. considering the symbolic use of the snake in the Christian religion), it is out of focus of the current study.

The inclination of children to engage and interact in favour of natural environment greatly depends on the emotions they get through experiences (Kellert 2002). Previous physical contact with snake was associated with positive attitude for snakes, but we cannot be affirmative about a causal relationship. Perhaps, those children that already liked snakes were also tempted to handle them, generating a circular effect between likeability and physical contact. However, the independent variable "Observed but never handled" was not retained in our analyses; suggesting that visual contact alone was not essential. In support of our interpretation, Prokop and Tunnicliffe (2008) observed that manipulating wildlife in the field decreased irrational aversion against frightening animals. In addition, previous experimental work provided further support to the notion that physical contact with snakes increases positive attitudes toward them (Morgan and Gramann 1989). Overall, available information fully converges to suggest that snake handling improves children perception of snakes, and this is likely mediated through an emotional response generated by the physical contact and surprise with respect to untrue statement about their biology. Notably, snakes captured in the field are actually often hot and soft, but rarely cold and never slimy.

Gender is perhaps one of the most important and consistent variables affecting attitudes toward animals (Morris and Morris 1965; Arrindel et al. 2000; Kaltenborn et

al. 2006; Prokop et al. 2009; Prokop and Tunnicliffe 2010). Although girls usually declare more sympathy and respect toward animals (Kellert and Westervelt 1984), we found less clear patterns with snakes (Prokop et al. 2009). Boys declared to be less afraid of snakes but to be more capable to kill them at the same time, and this negative association was unexpected (fear tends to trigger killing). We suggest that this trend may reflect different sex roles in our evolutionary history (in a simplistic view, males were predominantly hunters and females gatherers; Kaplan 1996), males were exhibited to stay face to face against predators (Hawkes et al. 1991). That is, females are expected to prefer escape strategies against predators more than males (Coss and Moore 2002). This issue requires further investigation however.

Taxonomic knowledge

Knowledge of organisms is obviously a key component to understanding biodiversity (Wilson and Tisdell 2005). Importantly, the capacity to name animal corresponds to the most basic level of knowledge. Previous studies showed that snakes are poorly known, often mixed with amphibians or even invertebrates (Yen et al. 2004; Kubiatko and Prokop 2007). Our results are convergent: knowledge was limited to few charismatic snakes, mostly large and exotic imprecise snake types or species. The high citation level of cobras and vipers might be driven by the fear-factor instilled by media and spread by rumours (Burghart et al. 2009). Further analyses to examine if, as expected cobras are more often cited in Nepal compared to Turkey for instance cannot influence the main outcome: children taxonomic and naturalistic knowledge about snakes was systematically very low, even in countries where different species can be easily observed. Clearly, progress is required to improve the knowledge of animal in children.

Conclusions

This study is the first to directly explore children's perception toward snakes across different geographic, and thus cultural, areas. Considering the complexity of such topic (owing to the interactions between gender, age, cultural, religious, geographical factors, etc.), we focused on the relationships between likeability and willingness of young schoolchildren to protect snakes.

Our results revealed several unexpected patterns. The proportions of children declaring that they like snakes, and that it is important to protect them, were high considering the well-established belief that snakes are unpopular animals. Adults should not project their own perception on children but question them carefully. Our results also showed that most children are reluctant to kill snakes; an attitude in strong contrast to what is observed in adults: the level of persecution against snakes, including non-venomous species, is extremely high in many countries (Greene 1997; Knight 2008; Fita et al. 2010). Several encouraging messages emerged from our analyses. Despite a relatively low level of knowledge, we found a high level of willingness to protect snakes; and more importantly, the level of aversion was superior to the declared propensity to kill snakes. Thus fear did not necessary translated into destruction, in children at least.

Overall, this study focusing on the supposedly less popular animals indicates that it is not necessary to focus on charismatic animals to convince children to protect wildlife. Environmental education should not neglect organisms declared as unpopular by adults; significant efforts must be produced to not limit conservation messages and actions to few iconic species. Contact with animals may be one of the best tools to convey positive emotional attitudes. Children should be brought into the field in close contact to wildlife to appreciate and respect all living forms including snakes (Lindemann-Matthies and Bose 2008; Erdogan et al. 2008).

Acknowledgments: This research was supported by a grant from the Conseil Général des Deux-Sèvres and the Région Poitou-Charentes. We thank Dr. M. Place for his help to set up the questionnaire, Stephen J. Mullin for improvement of the manuscript. R. Cambag photocopied the questionnaires. We also thank the teachers and children involved that kindly participated to this study.

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4.2.3 Evaluation d'une sortie de terrain avec les serpents (Article 4).

Influence of a field trip on schoolchildren' attitude toward unpopular organisms: an experience with snakes

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Word count: 4820

Submitted

Abstract

The general public prefers to support more easily conservation projects that focus on "loveable" species; most of the biodiversity on Earth is thus neglected. It is therefore essential to educate children about the value of a wide diversity of organisms, especially the less attractive ones. Because snakes are among the most disliked animals, they are suitable candidates for such endeavour. We evaluated the impact of a single field trip on the attitudes of more than 500 schoolchildren. The participants were involved in snake catching and were allowed to manipulate non-venomous snakes. The organisers limited their intervention to providing natural history information and carefully avoided to state that snakes should be protected. We used pre- and post-field trip questionnaires to gauge the feelings of the children. Although pre-surveys suggested that many schoolchildren like snakes *a priori*, their attitudes improved following field experience: almost all children declared that they like snakes and expressed a strong willingness to protect them. Such change was associated with an increase of the frequency in the responses of the terms linked with affectivity (e.g., "snakes are cute"…). Snake handling was the favourite activity, and physical contact with animals appears to be a crucial element to improve schoolchildren attitude for unpopular organism. Our results support for the promotion of field trips that include physical contact with wildlife over the current trend in the educational systems that promote virtual approaches.

Key-words: field experience, education, snake conservation, attitudes, willingness to protect, questionnaire survey

INTRODUCTION

Research and conservation programs are characterized by a strong disequilibrium towards several animal taxa (Balmford et al. 1996; Bonnet et al. 2002; Clark and May 2002; Seddon et al. 2005; Trimble and Van Aarde 2010). The high popularity level of few animals (e.g., polar bear, whale) is intensively used by media to raise conservation awareness, usually confined on exotic species living in remote locations (Clucas et al. 2008). Charismatic animals, almost exclusively represented by mammals and birds, receive disproportionally more attention and funding tfor conservation than other taxonomic groups. This bias might be the consequence of the general support of people for the protection of aesthetics, large or human-like species (Ward et al. 1998; Gunnthorsdottir 2001; Tisdell et al. 2006; Maresova and Frynta 2007; Martin-Lopez et al. 2007). Less popular organisms, including almost all common wild invertebrates and vertebrates relatively remain unknown for most adults and children. Awareness and interest for animals are limited to few exotics species and pets; and a very small proportion of the general public is actually capable to recognise more than a handful of local wild animal species (Lock 1997; Kellert 1985; Lindemann-Matthies 2005; Lindemann-Matthies 2006; Balmford et al. 2002). This biological illiteracy is worrying for conservation because it precludes the possibility to develop initiatives and participation of the citizen for conservation of the local environment and local species (Lindemann-Matthies 2002).

One of the efficient ways to redress such bias is to upgrade the biological and environmental education of children (Feinsinger 1987; Kellert 1996). One aim of biodiversity education is to extend the appreciation toward loveable species to a wider range of organisms; and school plays a key role in thet objective (Kellert 1993, 1996; Lindemann-Matthies and Bose 2008). Greater progress is expected using the most detested animals; it is indeed useless to reinforce the popular rating of already iconic species.

Because direct and concrete experiences improve the learning process, children must be immersed in the outdoor environment to ameliorate all aspects of their relationships with wildlife (Wilson 1996; Ballantyne and Packer 2002; Ballantyne et al. 2005; Lindemann-Matthies 2005; Prokop et al. 2007). Field trips are

unanimously considered as the most efficient way to promote positive attitudes by acting both on cognitive knowledge and affective development (Knapp and Barrie 2001; Kellert 2002). Physical experiences, wildlife handling and sensory engagement with natural environments are essential (Orion and Hofstein 1994; Wilson 1996; Ballantyne and Packer 2002; Lindemann-Matthies 2005; Prokop et al. 2007). Despite the widely acknowledged educational value of field trips, in practice, bringing schoolchildren into the field is a neglected activity (Prokop et al. 2007). Hands-on experience with living organisms has massively declined over time at school (Wilson 1996; Lock 1997; Barker 2002). Little time is allocated to educate children to biodiversity during school time, and it is almost exclusively done using virtual information (Ballouard 2005).

Snakes are suitable candidates to evaluate the effect of practical field experience on schoolchildren for several reasons. Firstly, snakes are among the most disliked animals, they trigger very strong levels of fear and destructive behaviours by most people (Morris and Morris 1965; Shalev and Ben Mordehai 1996; Gomez et al. 2004; Christoffel 2007). This situation provides a valuable opportunity for a significant positive attitude change (Kaplan 1997). Second, any project based on wild snake education is particularly challenging given the expected strong reluctance of teachers, parents, authorities, etc., to approve it (Gomez et al. 2004); therefore, any success will open the doors for many other less challenging projects. Third, snakes are difficult to observe; overcoming such complication will show that technical aspects should not always be considered as insuperable. Children can easily manipulate non venomous snakes, indeed these animals are particularly robust and by selecting appropriate species, there are almost no risk for both handled specimen and handlers. Finally, snake populations are facing a worldwide decline (Reading et al. 2010) but negative attitudes against them represent a major obstacle to set up specific conservation plans (Seshadri 1984; Burghart et al. 2009).

The aim of the current study was to examine the influence of a field experience based on snake population monitoring on the feelings of schoolchildren. We also aimed to evaluate the intensity of the expected difficulties associated with such activity: Complains by parents, negative reports etc. Because, in most cases school field trips will be limited to a single opportunity, we evaluated the impact of a one-

day field experience. A total of 472 schoolchildren (aged from 6-11 years old) participated in a project called "Life in the shcrubs". This project was set up to bring children in the field especially to discover snakes in their local natural environment and through physical participation to population monitoring, including snake searching, captures, identification, measurements, marking and releasing, thereby justifying ample handling opportunities. We addressed the following questions:

1- Does a single field experience with snakes improve schoolchildren attitudes?
2- What was the favourite activity experienced by the children?
3- What types of technical and administrative complications were generated by a project based on animals that generally garner public dislike?

METHOD

The current study was based on two main parts:
a) Surveys of schoolchildren attitudes before and after field trip.
b) Field trips with schoolchildren.

Surveys of schoolchildren attitudes

A total of 31 classes (520 schoolchildren) from urban and rural areas were selected to participate. Schools situated in the vicinity of the field sites (see below) were randomly contacted. The first teachers that responded positively were consequently involved. We used written questionnaires to assess schoolchildren attitudes. The questionnaire was developed under the supervision of a committee (including teachers specialized in schoolchildren psychology). During preliminary tests, we checked the capacity of the children to understand and to respond to questions about nature (unpublished data). Identical questionnaires were administrated before and after the field trip. Several questions were added to the post-field trip questionnaire, however to assess the preferred activities in the field.

The questionnaire contained a total of 47 closed and open questions and aimed to assess general issues (age, sex… of participant) in addition to snake specific topics. We were notably interested by the following issues:

- General feelings: we asked the children if they like or dislike snakes. If they are afraid by snakes. And to briefly explain why?
- Willingness to protect snakes: we asked to the children if they consider that it is important to protect snakes. In addition, among a list of ten animals encompassing a broad range of popularity (i.e. bear, beetle, dolphin, eagle, frog, panda, snake, spider, toucan, turtle) children were asked to choose three animals that must be protected in priority.
- To examine the possible influence of previous experience with snakes, we asked to the children if they had ever seen or handled a snake.
- Preferred activities: after their field trip, children were asked to rank in order of preference 8 activities (scored from 1 to 8) that revolved around the field trip (e.g., snake catching, observing other animals…).

The questionnaires were administered to 29 experimental classes (472 children participated to the field experience) and to 2 control classes (48 children did not participate to the field experience). The first questionnaire was proposed to the children at least one month before the field trip, and the second questionnaire two weeks after. During the same period the two questionnaires were administered to the control classes.

Field trips

The project was arranged through a collaboration between a ecology research laboratory (Centre d'Etudes Biologiques de Chizé, CNRS) and the main French governmental forest management organism (Office National des Forêts, ONF). Over the past decades, snake populations (*Coluber [Hierophis] viridiflavus, Elaphe [Zamenis] longissima, Natrix natrix* and *Vipera aspis*) have been monitored in the forest of Chizé (CF) (Western Central France, 79 district), especially in the 2600-ha biological reserve (Naulleau and Bonnet 1995; Bonnet and Naulleau 1996; Bonnet et al. 1999; Lelièvre et al. 2010). A network of concrete slabs (~900; 1.20m/0.80m size) was set up to increase snake catchability (several thousand snakes have been marked). In 2006, a similar, albeit smaller, field study was set up in the l'Arche de la Nature (ADLN) site, in a 450-ha forest managed in the vicinity of Le Mans (North Western France, 72 district).

Four snake species occur in this second field site: *Coronella austriaca, Natrix natrix, Elaphe longissima,* and *Vipera aspis*; and snakes are monitored using a network of 115 concrete slabs (several hundreds of snakes marked). In both sites, the network of concrete slabs provided an opportunity to catch snakes with limited searching effort. Over time important ecological data on snakes have been accumulated. The snake population monitoring programs served a basis for the educational project.

In spring 2008, 2009 and 2010, 23 one-day field trips were organized with different schools (1.2 classes per field trip on average). Twenty six classes visited the CF site and three visited the ADLN site. Teachers and their classes (typically 20 to 30 schoolchildren) discovered native snakes in their natural environment and the scientific activities associated with population monitoring. Field trips were standardised: The classes arrived in the morning and the activity started almost immediately with snake searching. Using heavy-duty gloves, each child lifted at least one slab under the supervision of the organisers; approximately 150 slabs were examined per trip, representing two to three hours of searching. In case of snake finding, the organiser captured the snake(s) by hand. Children were invited to handle the snake during several minutes, and the specimen was then put in a cotton bag until measurements could be obstained. Snake species, sex and identity (when the individuals were already marked) were recorded. In an opportunistic way, other animals were captured and carefully handled notably amphibians, spiders (e.g., *Pisaura mirabilis* is common), insects (many beetles), but others were simply observed (birds, mammals, lizards…) due to the logistic difficulties to capture and manipulate them. All the snakes collected (from one to more than ten) were brought in the lunch site. After lunch (1 hour on average), the schoolchildren observed the snakes in more details. Each individual was re-identified (species, sex), measured (head, length), weighed, palpated, and permanently marked (and named by the children) in case of first capture. Children had then ample opportunity to (re-) manipulate and photograph the snakes. Then, each snake was released by children under the slab of capture. During the 23 field trip organized at least one snake was captured, most of the snakes were found under the slabs and few basking in the sun. However, to ensure that the children would see and manipulate living snakes we also brought individuals caught nearby (exactly from the same population, but under other slabs

than those surveyed with the children) one to three days before. Such supplementary snakes were used when only one or two snakes were captured by the children, in order to show at least two species and two sexes. Consequently all children manipulated at least *H.v.* and *E.l.* On several occasions, the schoolchildren had the opportunity to discover the aspic vipers, they were not allowed to capture and handle them; although they touched the vipers while the snakes were handled by the organisers.

The organisers carefully avoided to influence the willingness of the children to protect snakes for ecological reasons, for instance by stating that snakes deserves protection, or that they are important elements in the trophic web. The explanations provided to the children were strictly limited to natural history.

Analyses

Closed questions (e.g., "Do you like snakes?") generated simple answers ("Yes", No, or "It depends"). Open questions (e.g. "Why do you like snakes?") generated complex answers. Consequently, we scrutinized and classified such complex responses into height categories to perform the analyses.

1. Affective: children clearly introduced an affective factor in their written response. For instance using the terms: "because they are cute or nice"; "They are cool".
2. Physical aspect: words related to colour, size, or feeling during handling (e.g. temperature, odour…) constituted the response.
3. Behaviour: snake behaviour (basking in the sun, flying away…) were the criteria retained.
4. Dangerousness: this category was established on the use of terms such as "They are venomous", "Dangerous", "They can bite"…
5. Fear: terms such as "I m afraid", or" I panic" were retained in this category.
6. Naturalistic and utilitarist: children employed terms related to the importance of the snakes for science or ecosystems; for instance, "They are predators", "they are usefull"…

7. Others: this category includes answers not easily classified (e.g., "I did not see it"; "they are unique"; "They are alive"...
8. No response or "I don't know".

In this study, we analysed a subset of the most relevant questions and responses to gauge the influence of a field trip of schoolchildren attitudes in relation to the conservation issues, notably fear, or willingness to protect. Although not presented, comprehensive analyses did not produce any results that contradicted our conclusions, or irrational outcomes. Analyses of contingency tables were performed with Statistica 7.1.

RESULTS

Although many (86.1%, N=472) schoolchildren declared to have already observed a snake (e.g., in a zoo, pet, shop…) at the onset of our surveys, the majority (52.9%) never handled one. Almost all children (but not all, 15 remained afraid) wanted to, and actually did manipulate the snakes during the field trip, such later proportion raised to 96.9% (χ^2= 284.25, df=1 p<0.0001).

Influence of the field trip on schoolchildren attitude for snakes

We found a difference in the proportion children that declared to be afraid by snakes before and after the field trip (χ^2= 88.37, df=2, p<0.0001). Such proportion decreased markedly, from 33.2% to 10.6% whilst the number of indecisive children increased from 10.3% to 26.8% (Figure 1). We observed also a significant change in the control group however, with the number of children that declare to have fear increase (from 6.2% to 26.2%), (χ^2= 8.10, df=2, p=0.02).

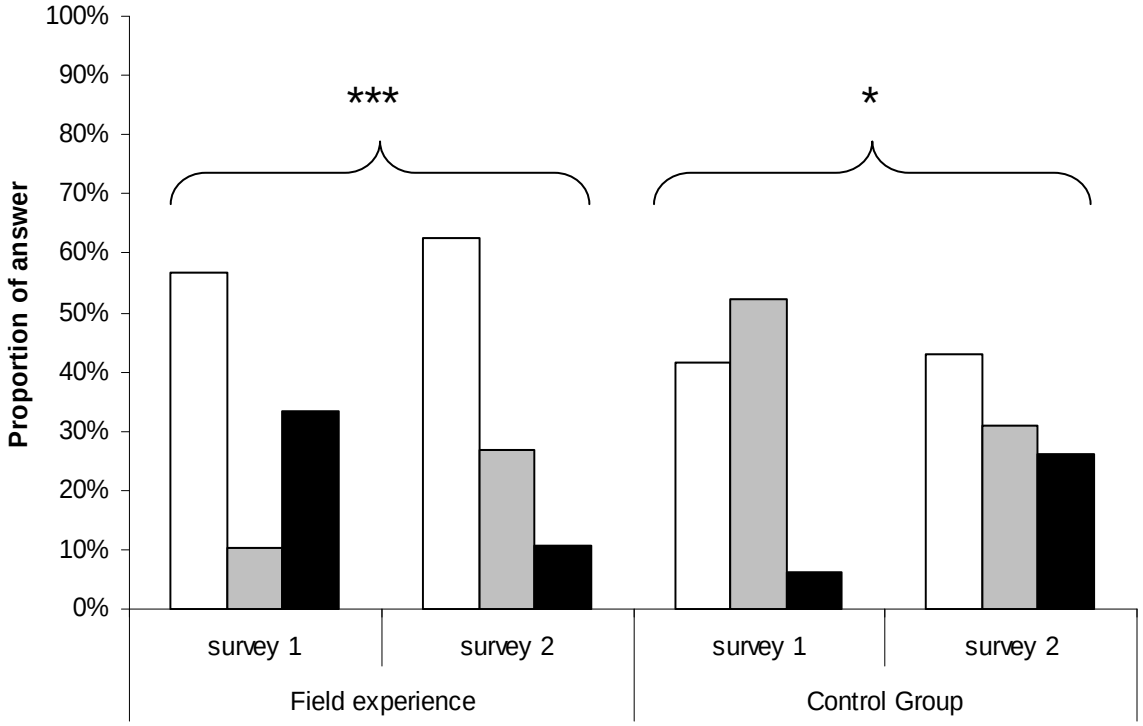

Figure 1: Proportion of children that declared to have no fear of snakes (white bars) have fear (black bars) or indecisive (grey bars) during presurvey and post-survey among children that have field experience (N=472) and control group (N=48) (*** = $p < 0.0001$; * = $p < 0.05$).

The proportion the children that declared that they like snakes increased from 41.9% to 53.0% ($\chi^2=64.05$, df=2, $p<0.0001$), whilst no change was detected in the control group ($\chi^2=1.98$, df=2, $p=0.371$; Figure 2). The proportion of children that declared to dislike snakes decreased from 22.3% to 4.4%, with no change in the control group.

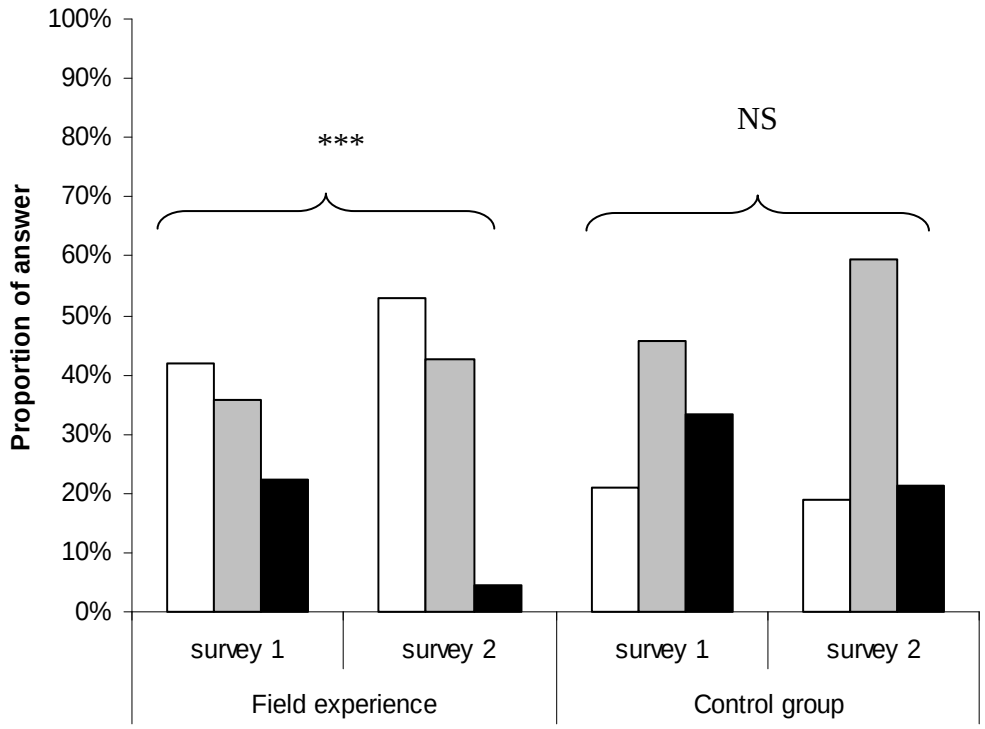

Figure 2: Proportion of children that declared to like snake (white bars) dislike (black bars) or indecisive (grey bars) during presurvey and post-survey among children that have field experience (N=472) and control group (N=48) (*** = p <0.0001; NS = p>0.05).

Focusing on the responses of those children that declared to like snakes both before and after the field experience, and hence that apparently exhibited a stable attitude, we nonetheless observed a significant change in the explanations they provided: the proportion of responses referring to affective factors increased from 29.1*% to 47.0*% (χ^2=17.92, df=7, p=0.01; Figure 3).

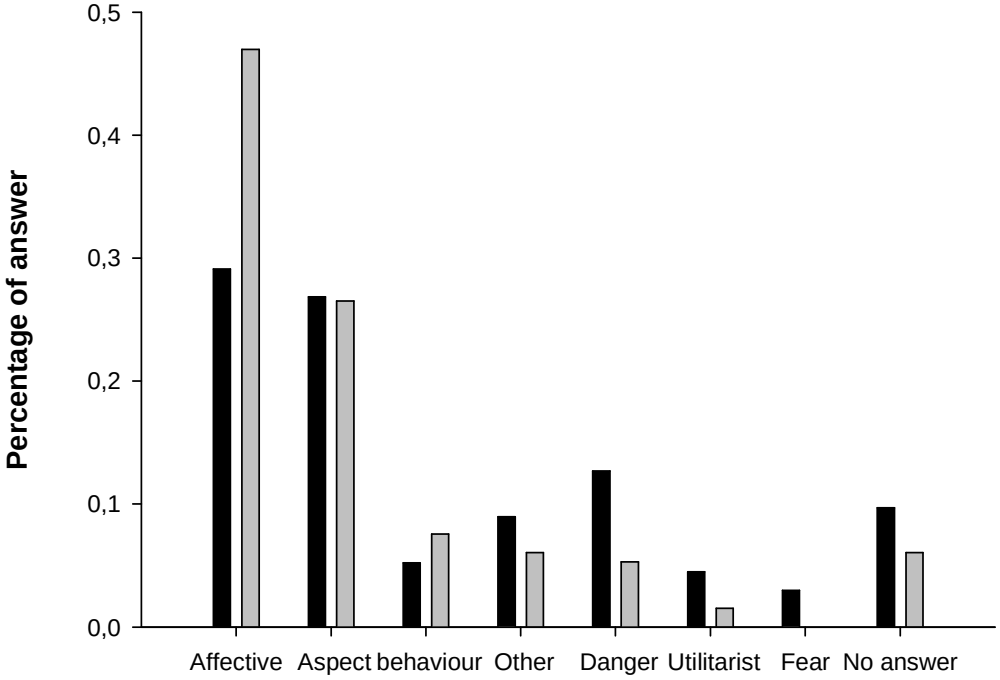

Figure 3: Proportion of the answer categories explaining why children declared to like snake before (Black bars) and after the experience (grey bars).

Willingness to protect the snakes

Following field trip, the number of children declaring that is it important to protect snakes increased from 77% to 94% (χ^2=43.61, df=1, p<0.0001), with no change in the control group (χ^2=1.22, df=1, p=0.269; Figure 4).

Among the 3 animals chosen by the schoolchildren to be protected in priority, bear, panda, dolphin and turtle were largely more often selected by the children during the first survey (Figure 5). After the field trip, such proportion was significantly modified, snakes were more selected after (73%) than before (31%) the field trip (χ^2=105.50, df=2, p<0.0001), and they even surpassed the stars (e.g. panda 65%, dolphin 51%).

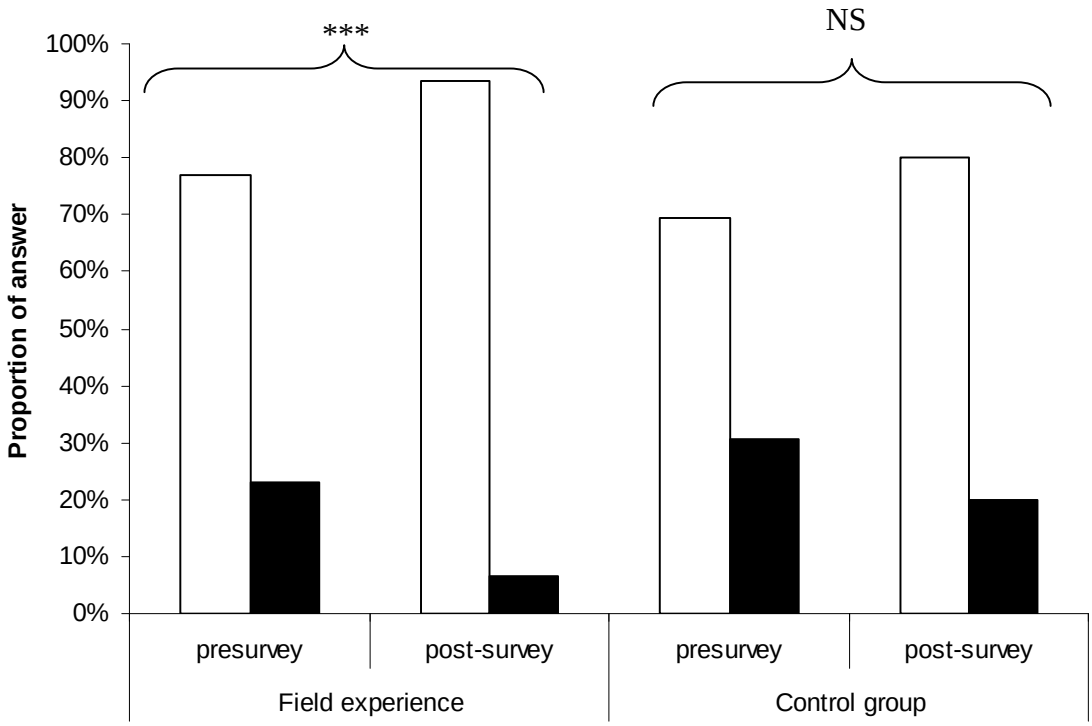

Figure 4: Proportion of children that declared that snakes shpuld be protected (white bars) or not (black bars) during presurvey and post-survey among children that have field experience (N=426) and control group (N=48) (*** = p <0.0001; NS=p>0.05).

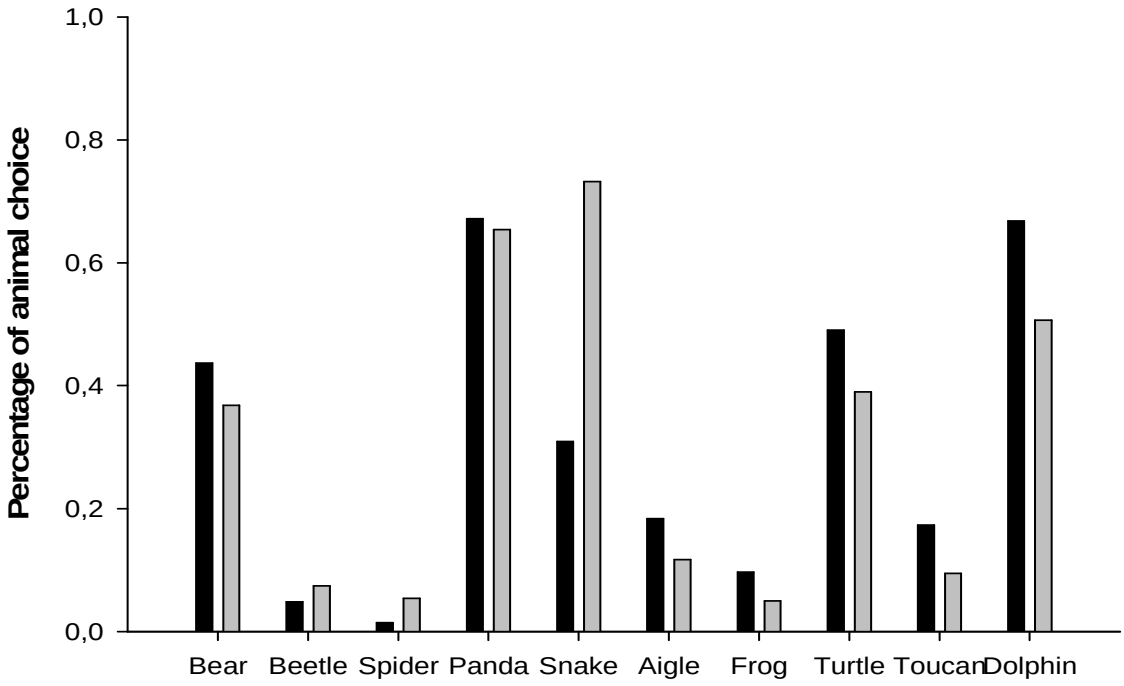

Figure 5: Proportion of each animal chosen by the schoolchildren to be protected before (black bars, N=206) experience and after (grey bars, N=442).

Preferred activities

Among the 8 activities proposed during the field trip, snake handling was largely the favorite (Mann Whitney ANOVA, U= 29.621, p < 0.001; N=193).

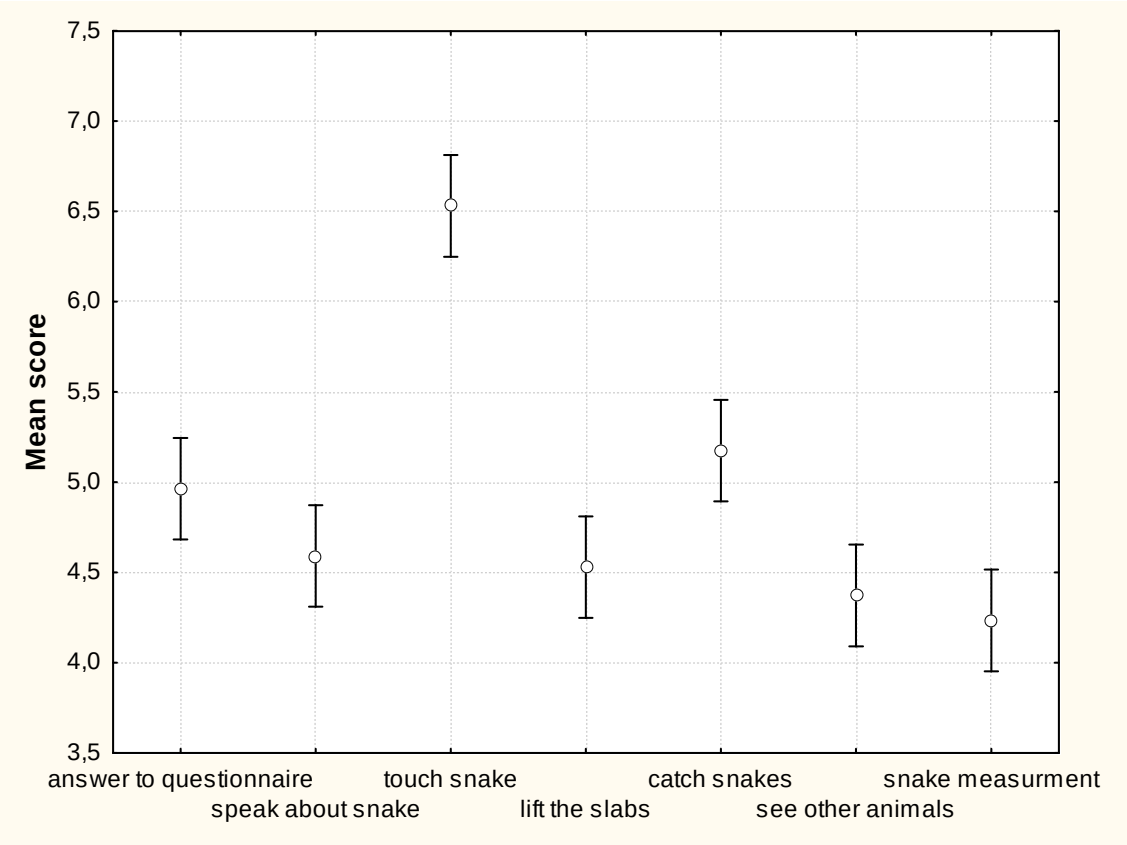

Figure 6: Mean score of the activities that were declared to be preferred by the schoolchildren after experience.

DISCUSSION

Although several studies showed the positive impact of outdoor learning to increase appreciation, concern, and knowledge about biological diversity and for conservation purpoises, none involved young children catching and handling unpopular organisms in the field (Bogner 1998, Zoldosova and Prokop 2006). For many adults, encountering snakes is a traumatic experience that usually triggers destructive behaviours (Seshadri 1984). The expected difficulties with teachers, schools, parents etc. never occurred despite the dimensions of our experiment in terms of sample size (more than 450 children, 2 sites), duration (3 years), and species involved (e.g., venomous aspic vipers). We had no accident in the field, we received zero parent complaints, and most of the teachers were ready to renew the experience

with other classes. Thus, the first important lesson of our study is that we often imagine excessive difficulties to organise field trips. Outdoor experiences should be more intensively encouraged and organised on the ground of practices.

Our results also show that if snakes are indeed feared or hated by most adults; this does not necessarily apply with children. Even the survey before the field trip revealed moderate negative attitudes of children toward snakes. Importantly however, a substantial proportion of children did not like the snakes and were afraid at the beginning of our study, thus space for progress was available. Thanks to the field trip, almost all the children had the opportunity to discover, capture and to handle native snake species in their natural habitats. Although we have investigated few aspects of the childrens attitudes, our results show, at least in the short term (months) that the field experience with snakes improved children's attitudes towards snakes. Indeed, because we focused on one of the most disliked animal and because fear attitude and likeability have the most important impact on behavioural attention and willingness to protect (Kellert 2002; Christoffel 2007; Knight 2008), such improvement provides a strong support about the efficiency of field education in conservation perspectives demonstrated by other authors (Zint et al. 2002; Lindemann-Matthies 2006; Prokop et al. 2007). After the field trip almost all children wanted to protect snakes. Children even ranked the snake at the level of the iconic animals such as panda and dolphin.

After only one day of field experience, the improvement of the children's attitude was spectacular. This contrasts with other studies that evaluated the efficiency of snake education program (Morgan and Gramann 1989; Gomez et al. 2004). For example we found that positive attitudes decreased one week after interpretative talks.

We believe that the efficiency of our approach is essentially due to the virtue of the field trip, notably the emotion generated by snakes searching and by the physical contact between children and animals; talks (e.g., about the importance of species in the ecosystem) are far less efficient. In support of the assumption that the improvement of the attitude was generated through the activation of an affective relationship between children and snake, we observed that children preferred snake handling and, consequently, that the affective category responses increased. Our

study thus conforms to the growing evidence that it is more important to feel rather than to know to develop concern and appreciative attitude toward animals (Iozzi 1989; Kellert 1996; Wilson 1996). To learn, children have to be engaged in real experiences rather that receive ecological lessons in a classroom (Lindemann-Matthies 2002; Dettmann-Easler and Pease 1999). In general, so little time is engaged in biodiversity education (Barker et al. 2002; Brewer 2002; Kellert 2002; Randler 2008), that it is essential to adopt the most efficient way that will favor long-term concern and awareness of children toward organisms. Field experiences had the potential to trigger the powerful affective channel of children (Chawla 1999). Handling a warm and "cute" snake is likely the experience the children will probably not forget, but they will not retain the name of the species.

Unfortunately, such practical approach of the environmental education is actually neglected. Educational systems heavily promote the use of virtual and intellectual information means (Barker et al. 2002; Brewer 2002; Wells and Lewis 2006; Louv 2008; Randler 2008). Direct and emotional experiences of local natural areas are replaced with virtual ones (Levi and Kocher 1999; Pyle 2002). Outdoor education it however the only way to (re)connect children with local environment (Lindemann-Matthies 2006). Our study also suggests that the over use of few flagship animals on the grounds that they will offer and otherwise unhoped-for protection to the rest of wildlife is not justified. Even snakes can easely become popular (Feldhamer et al. 2002). All children may develop concern and awareness toward any kind of animal, but conservationist and educators should play a more balanced role, and they should bring the children into the field to discover all forms of life, not only the selected club of icons.

Acknowledgments: We warmly thank the teachers and children who participated with a great enthusiasm: Michèl Place, Hélène, Philippe Roy, Dominique Goriou, Stephanie Rudel, Vincent Barribault, Madame La Roche, Melle Lorieux, Madame Arnault, Michel Servant, Marilyn Michaud, Michel Shabroux, Julien Dugast, Evelyse Viaud, Claudia Juan, Magalie, Francis, Marie-Odyle Reynaud, Marie-Claude Bourdin, Guillaume Guérin, Béatrice Motard, Virginie Geneau, Mr Julien, Madame Denivillères, Madame Farizon, David L'hommédé, Julien Fièvre, Béatrice Bonamy,

and Catherine Martins. This research was supported by a grant from the Conseil Général des Deux-Sèvres and the Région Poitou-Charentes. We thank Dr. M. Place for his help to set up the questionnaire; D. Barré (ONF) who help us to set up the field site. R. Cambag photocopied the questionnaires and M. Simonin who filled in the data set.

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4.3 Du statut des populations d'ophidiens à leur conservation

4.3.1 Etat des populations de serpents (Article 5)

Are snake populations in widespread decline?

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Biology letters doi:10.1098/rsbl.2010.0373

Abstract

Long-term studies have revealed population declines in fish, amphibians, reptiles, birds and mammals. In birds, and particularly amphibians, these declines are a global phenomenon whose causes are often unclear. Among reptiles, snakes are top predators and therefore a decline in their numbers may have serious consequences for the functioning of many ecosystems. Our results show that, of 17 snake populations (8 species) from the UK, France, Italy, Nigeria and Australia, 11 have declined sharply over the same relatively short period of time with 5 remaining stable and one showing signs of a marginal increase. Although the causes of these declines are currently unknown we suspect that they are multi-faceted (such as habitat quality deterioration, prey availability), and with a common cause e.g. global climate change, at their root.

Keywords: snakes; sharp population declines; carrying capacity; global climate change

INTRODUCTION

There is growing evidence from long-term studies of worldwide declines in vertebrate populations: fish (Harshbarger *et al*. 2000; Light & Marchetti 2007), amphibians (Wake 1991; Alford *et al*. 2001), reptiles (Gibbons *et al*. 2000; Winne *et al*. 2007), birds (King *et al*. 2008) and mammals (Mcloughlin *et al*. 2003). Some of these declines can be directly attributable to known causes e.g. pollution (Harshbarger *et al*. 2000), habitat loss/change (Gibbons *et al*. 2000; Feyrer *et al*. 2007), disease (Pounds *et al*. 2006; LaDeau *et al*. 2007), over-exploitation (Whitehead *et al*. 1997) or climate change (Collins & Storfer 2003; Reading 2007), whilst for others the causes remain either unclear (Kiesecker *et al*. 2001; Collins & Storfer 2003) or unknown (Gibbons *et al*. 2000; Winne *et al*. 2007). Although there is little evidence that snake populations are in decline, there are reports for other reptiles (Gibbons *et al*. 2000) and there is consensus, amongst herpetologists, that snakes may, indeed, be disappearing

worldwide (Mullin & Seigel 2009). One possible reason for this view is the relative lack of long-term individual based studies of snake populations. Our data represents the first evidence that some species occurring in the tropics (Nigeria) have shown similar patterns of decline to others found in southern (Italy), central (France) and northern Europe (UK).

MATERIALS AND METHODS

We used data from studies of geographically widespread snake populations covering a broad diversity of snake lineages and environmental situations to determine changes in status over time (Table 1). Survey methodologies were identical between years at each study site but not between sites. *Coronella austriaca* (*Ca*) and *Natrix natrix (Nn*[1]) were surveyed one day/week for 21 weeks annually (April to October). *Vipera aspis* (*Va*[1]) was surveyed five days/week for 5 months annually. *Hierophis viridiflavus* (*Hv*[1]) and *Zamenis longissimus* (*Zl*[1]) were sampled using daily collections of road-kills for five months annually. *H. viridiflavus* (*Hv*[2]), *Z. longissimus* (*Zl*[2]) and *N. natrix* (*Nn*[2]) were surveyed three days/week for 5 months annually. *Notechis scutatus* (*Ns*) was surveyed for two weeks each spring. *V. aspis* (*Va*[2,3]) was surveyed one day/week annually (March to November). *V. ursinii* (*Vu*[1,2]) was surveyed one day/week annually (April to October). *Bitis gabonica* (*Bg*), *B. nasicornis* (*Bn*), *Python regius* (*Pr*) and *Dendroaspis jamesoni* (*Dj*) were all studied in sympatry for two days/week annually (May to October). Importantly, the methods used to monitor population trends were consistent through time at each site. Although we used simple techniques to count snake numbers, we nevertheless obtained only two distinct clear patterns (see results), showing that uncontrolled factors (e.g. catchability, annual climatic fluctuations) did not obscure the detection of major trends. For all populations (excluding road-kills), we collected capture-mark-recapture data as we intended to produce demographic parameters. However, since the resulting population estimates correlated with count data, we opted to use the latter because they were similar to road-kill counts. Although simple counting underestimates true population size (unpublished data) it does provide an index of abundance. We used the simplest methods for consistency among study cases and

sites, and also for conciseness. Each captured individual in each independent study was given a permanent individual mark, using either ventral scale clipping or pit-tagging (passive integrated transponder), and thus the current study did not include pseudo-replicates (re-sampling the same individuals within a year was thus avoided). Importantly, several snake populations were monitored in well-protected areas (e.g. Chizé Natural Reserve, Gran Sasso National Park) where habitats were not directly perturbed by human intervention.

All statistical tests were two-tailed, with alpha set at 5%. Data normality was tested prior to using parametric tests.

Table 1. Site locations, study duration and responsible authors for each species.

Species	**Country**	**Site status**	**Latitude**	**Longitude**	**Duration**	**Researcher**
Ca	UK	Protected	50° 44'N	2° 08'W	1997-2009	CJR
Nn[1]	UK	Protected	50° 44'N	2° 08'W	1997-2009	CJR
Va[1]	France	Unprotected	47° 04'N	2° 00'W	1993-2008	GN/XB
Hv[1]	France	Unprotected	46° 07'N	0° 25'W*	1995-2009	XB/JMB
Zl[1]	France	Unprotected	46° 07'N	0° 25'W*	1994-2009	XB/JMB
Hv[2]	France	Protected	46° 07'N	0° 25'W	1997-2009	XB/JMB
Zl[2]	France	Protected	46° 07'N	0° 25'W	1997-2009	XB/JMB
Nn[2]	France	Protected	46° 07'N	0° 25'W	1995-2009	XB/JMB
Va[2]	Italy	Protected	43° 16'N	11° 09'E	1989-2008	LML/LR/GA
Va[3]	Italy	Protected	43° 42'N	10° 30'E	1989-2009	LML/LR/GA
Vu[1]	Italy	Protected	42° 27'N	13° 42'E	1987-2008	EF/LML/GA
Vu[2]	Italy	Protected	42° 22'N	13° 43'E	1987-2008	EF/LML/GA
Bg	Nigeria	Protected	4° 38'N	7° 55'E	1995-2008	GCA/LML
Bn	Nigeria	Protected	4° 38'N	7° 55'E	1995-2008	GCA/LML
Pr	Nigeria	Protected	4° 38'N	7° 55'E	1995-2008	GCA/LML
Dj	Nigeria	Protected	4° 38'N	7° 55'E	1995-2008	GCA/LML
Ns	Australia	Protected	32° 07'S	115° 39'E	1997-2009	XB/DP

Ca-Coronella austriaca; *Nn-Natrix natrix*; *Va-Vipera aspis*; *Hv-Hierophis viridiflavus*; *Zl-Zamenis longissimus*; *Vu-Vipera ursinii*; *Bg-Bitis gabonica*; *Bn-Bitis nasicornis*; *Pr-Python regius*; *Dj-Dendroaspis jamesoni*; *Ns-Notechis scutatus*.

RESULTS

Our data revealed an alarming trend. The majority of snake populations had declined sharply, and synchronously (figure 1), whilst a few had remained stable (one species from the UK (*Nn*[1]), 2 from mainland Europe (*Nn*[2], *Zl*[2]), one from Nigeria (*Dj*) and one from Australia (*Ns*)), and one showed evidence of a very weak increase (*Hv*[2]) (figure 2). All the stable populations were situated in protected areas whilst all the populations occurring in areas subject to increasing anthropogenic pressures declined (table 1). However, 8 snake populations from protected areas (*Ca*, *Va*[2,3], *Vu*[1,2], *Bg, Bn*, *Pr*) also exhibited large and surprisingly similar patterns of decline. Most of the declining populations exhibited a 'tipping point' effect (Andersen *et al*. 2008), with a period of relative stability, up until about 1998, followed by a steep decline, over a period of approximately 4 years, and then a second period of relative stability, but at reduced population densities and with no subsequent sign of recovery to pre-crash levels.

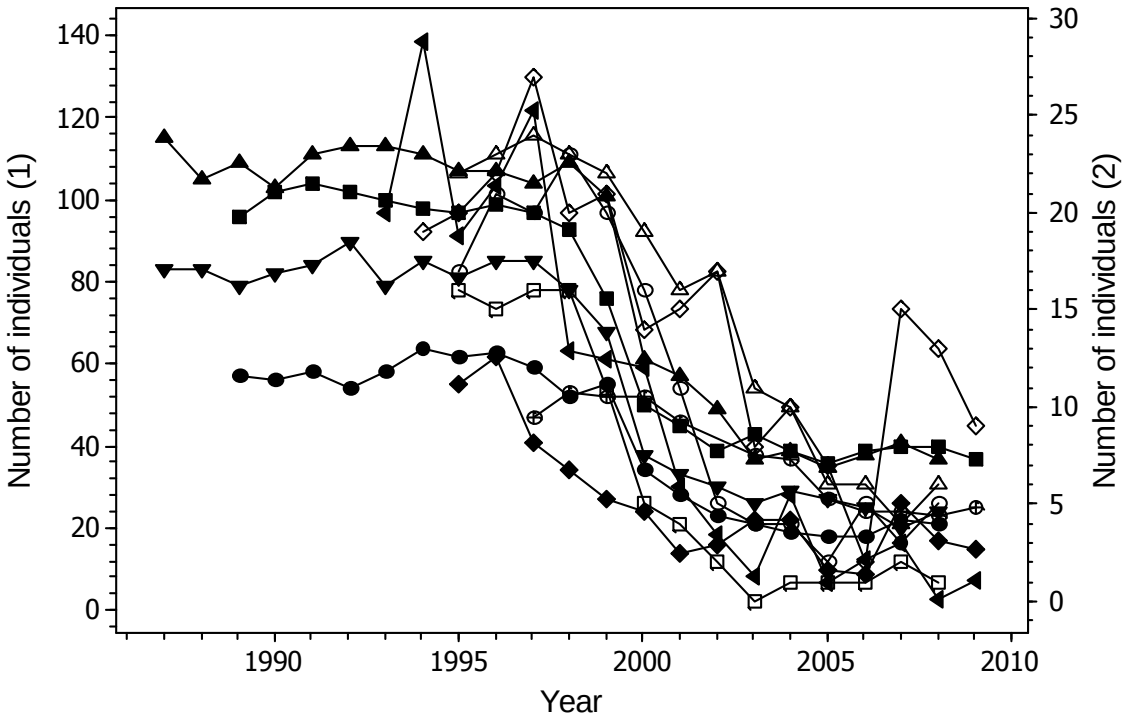

Figure 1: Annual total number of individuals found for each declining snake species/population.
Axis-1: ◀ -*Va*[1]; ●-*Va*[2]; ■-*Va*[3]; ▲-*Vu*[1]; ▼-*Vu*[2]; ⊕-*Ca*; ◆-*Hv*[1].
Axis-2: ○-*Bg*; □-*Bn*; △-*Pr*; ◇-*Zl*[1]. Values shown for *Va*[1] are ⅓ true values. See Table 1 for key to snake species abbreviations and country of origin.

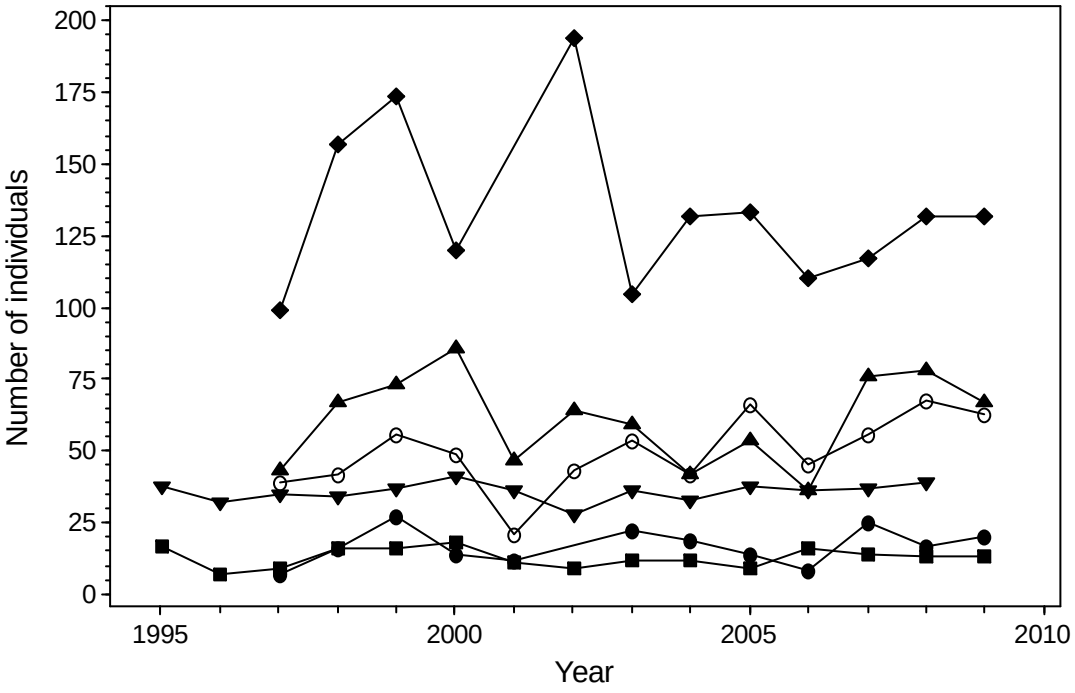

Figure 2. Annual total number of individuals found for five stable and one increasing snake species/ populations.
● - *Nn*[1]; ■ - *Nn*[2]; ▲- *Zl*[2]; ▼- *Dj*; ○ - *Hv*[2]; ♦ - *Ns*. Linear regression analyses of the change in the number of individuals of each species present over time - Stable populations: *Nn*[1]-nos = -684 + 0.350 Year, $P = 0.476$, $r^2 = 0.052$, $n = 12$; *Nn*[2]-nos = 6 + 0.04 Year, $P = 0.987$, $r^2 = 0.0$, $n = 15$; *Zl*[2]-nos = -522 + 0.290 Year, $P = 0.814$, $r^2 = 0.005$, $n = 13$; *Dj*-nos = -237 + 0.136 Year, $P = 0.548$, $r^2 = 0.031$, $n = 14$; *Ns*-nos = 2936 – 1.40 Year, $P = 0.537$, $r^2 = 0.039$, $n = 12$. Increasing population: *Hv*[2]-nos = -3813 + 1.93 Year, $P = 0.037$, $r^2 = 0.339$, $n = 13$. See Table 1 for a key to species abbreviations.

The observed population declines were not uniform across the sexes (table 2) such that, with the exception of *Z. longissimus* (*Zl*[1]), there was a significant difference (Student $t = 2.64$, $df = 12$, $P = 0.022$) between the mean decline of females (mean = 81.2%, *s.d.* = 8.071, $n = 10$, *Range*: 69.5% - 96.0%) and males (mean = 63.8%, *s.d.* = 19.22, $n = 10$, *Range*: 25.2% - 89.2%). However, although there was no significant difference ($t = -1.45$, $df = 3$, $P = 0.243$) between the magnitude of the decline of females from Europe (mean = 78.9%, *s.d.* = 7.39, $n = 7$) and Nigeria (mean = 86.7%, *s.d.* = 8.03, $n = 3$) there was one ($t = -2.43$, $df = 7$, $P = 0.045$) between that of males from Europe (mean = 57.2%, *s.d.* = 18.80, $n = 7$) and Nigeria (mean = 79.2%, *s.d.* = 9.71, $n = 3$). The sex ratio within the stable populations did not change over time.

Table 2. Comparing the mean numbers of individuals (♂♂ and ♀♀) found each year before and after the observed decline of each species shown in Fig. 1.

Sp.	Sex	Period (before)	Mean (*n*)	Period (after)	Mean (*n*)	Comparing means *t*	*P*	*df*	Decline
Ca	♂	1997-01	27.8 (5)	2004-09	20.8 (6)	3.07	0.015	8	25.2%
	♀	1997-01	22.2 (5)	2004-09	5.8 (6)	11.29	<0.0001	5	73.9%
Va[1]	♂	1993-97	163.2 (5)	2002-09	26.6 (8)	9.11	<0.0001	5	83.7%
	♀	1993-97	168.0 (5)	2002-09	10.9 (8)	9.46	0.001	4	93.5%
Hv[1]	♂	1995-96	40.0 (2)	2001-09	12.8 (9)	8.04	0.079	1	68.0%
	♀	1995-96	18.5 (2)	2001-09	4.0 (9)	15.14	<0.0001	7	78.4%
Zl[1]	♂	1994-99	16.0 (6)	2003-09	5.4 (7)	6.27	<0.0001	9	66.2%
	♀	1994-99	5.5 (6)	2003-09	3.7 (7)	1.63	0.134	10	32.7%
Va[2]	♂	1989-99	32.4 (11)	2002-08	14.9 (7)	16.61	<0.0001	15	54.0%
	♀	1989-99	25.6 (11)	2002-08	5.5 (7)	35.57	<0.0001	15	78.5%
Va[3]	♂	1989-98	57.5 (10)	2002-09	30.9 (8)	26.05	<0.0001	15	46.3%
	♀	1989-98	41.3 (10)	2002-09	8.3 (8)	39.37	<0.0001	15	79.9%
Vu[1]	♂	1987-99	60.3 (13)	2003-08	27.5 (6)	24.64	<0.0001	16	54.4%
	♀	1987-99	48.0 (13)	2003-08	10.3 (6)	41.96	<0.0001	16	78.5%
Vu[2]	♂	1987-99	46.3 (13)	2003-08	14.3 (6)	24.34	<0.0001	16	69.1%
	♀	1987-99	35.4 (13)	2003-08	10.8 (6)	25.05	<0.0001	15	69.5%
Bg	♂	1995-99	10.8 (5)	2002-08	2.3 (7)	18.09	<0.0001	8	78.7%
	♀	1995-99	9.4 (5)	2002-08	1.7 (7)	10.93	<0.0001	4	81.9%
Bn	♂	1995-98	8.3 (4)	2002-08	0.9 (7)	20.46	<0.0001	8	89.2%
	♀	1995-98	7.5 (4)	2002-08	0.3 (7)	21.06	<0.0001	5	96.0%
Pr	♂	1995-99	12.6 (5)	2005-08	3.8 (4)	15.58	<0.0001	5	69.8%
	♀	1995-99	10.2 (5)	2005-08	1.8 (4)	11.92	<0.0001	5	82.3%

See Table 1 for a key to species abbreviations. Comparisons between means were made using Student's t-test.

DISCUSSION

The snake population declines shown by these data, though alarming, remain observational as we have no firm evidence to suggest possible causes. Two thirds of

the monitored populations collapsed, and none have shown any sign of recovery over nearly a decade since the crash. Unfortunately, there is no reason to expect a reversal of this trend in the future. Interestingly, 6 of the 8 declining species are characterised by having small home ranges, sedentary habits and ambush foraging strategies whilst, with the exception of *N. scutatus* (*Ns*), whose movements are restricted by the small size of the island on which it occurs, all of the stable/increasing species are wide ranging, active foragers (Luiselli *et al*. 2000). These patterns fit the prediction that "sit-and-wait foragers may be vulnerable because (1) they rely on sites with specific types of ground cover, and anthropogenic activities disrupt these habitat features, and (2) ambush foraging is associated with a suite of life-history traits that involve low rates of feeding, growth, and reproduction" (Reed & Shine 2002).

In Europe, although habitat loss/change may be the main cause of these declines, other factors, such as prey availability, habitat edge destruction and pollution, may also be involved because several declines occurred in well-protected areas. A similar scenario may have also occurred in Nigeria, where the study sites that included both declining and stable populations were adjacent to the Stubbs Creek Forest Reserve, which is a well-protected area. Nevertheless, the shape of the observed population declines, leading to significantly reduced snake densities after the 'crash', is indicative of a change in habitat quality, rather than habitat loss, with a subsequent reduction in its carrying capacity e.g. reduced prey availability (Mcloughlin *et al*. 2003). It is possible that the declines are co-incidental and that the causes vary between sites. However, this seems unlikely as all the declines occurred during the same relatively short period of time and over a wide geographical area that included temperate, Mediterranean and tropical climates. We suggest that, for these reasons alone, there is likely to be a common cause at the root of the declines and that this indicates a more widespread phenomenon (Feyrer *et al*. 2007; LaDeau *et al*. 2007; Pounds *et al*. 2006). For instance, synchrony could be attributable to common stochastic environmental factors (Weatherhead et al. 2002); worldwide and synchronized declines have been already observed in amphibians (Pounds et al. 2006). Although, in this study, the small sample size (17 populations of 8 species)

with taxonomic, geographic and ecological biases makes extrapolation difficult the declines are sufficiently striking to warrant attention.

Overall, the worrying trends we report suggests that snake researchers should work more closely with one another to better identify the factors responsible for the widespread population declines of snakes in order to understand, stop and ultimately reverse, them.

Acknowledgements

Funding was provided by NAOC, Aquater Snamprogetti, T.S.K.J., ENI, Chelonian Research Foundation, Turtle Conservation Fund and Conservation International (Nigeria), Gran Sasso-Monti della Laga National Park, RomaNatura (Italy, CG79, CNRS (France), ARC and DEP (Australia). Permits were issued by Natural England (UK), Gran Sasso-Monti della Laga National Park (Italy) and the Federal Department of Forestry (Nigeria). Field co-workers included F.M. Angelici, C. Anibaldi, D. Capizzi, M. Capula, E.A. Eniang and O. Lourdais, as well as many students and volunteers who cannot be cited.

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4.3.2 Perspectives : des aménagements pour préserver les populations de serpents et réaliser des activités pédagogiques

Bonnet X. ; **Ballouard J-M.** ; Simonin M., Levadoux J-B., Lucas A., Provost G., Lassey J-L. et Barré D.

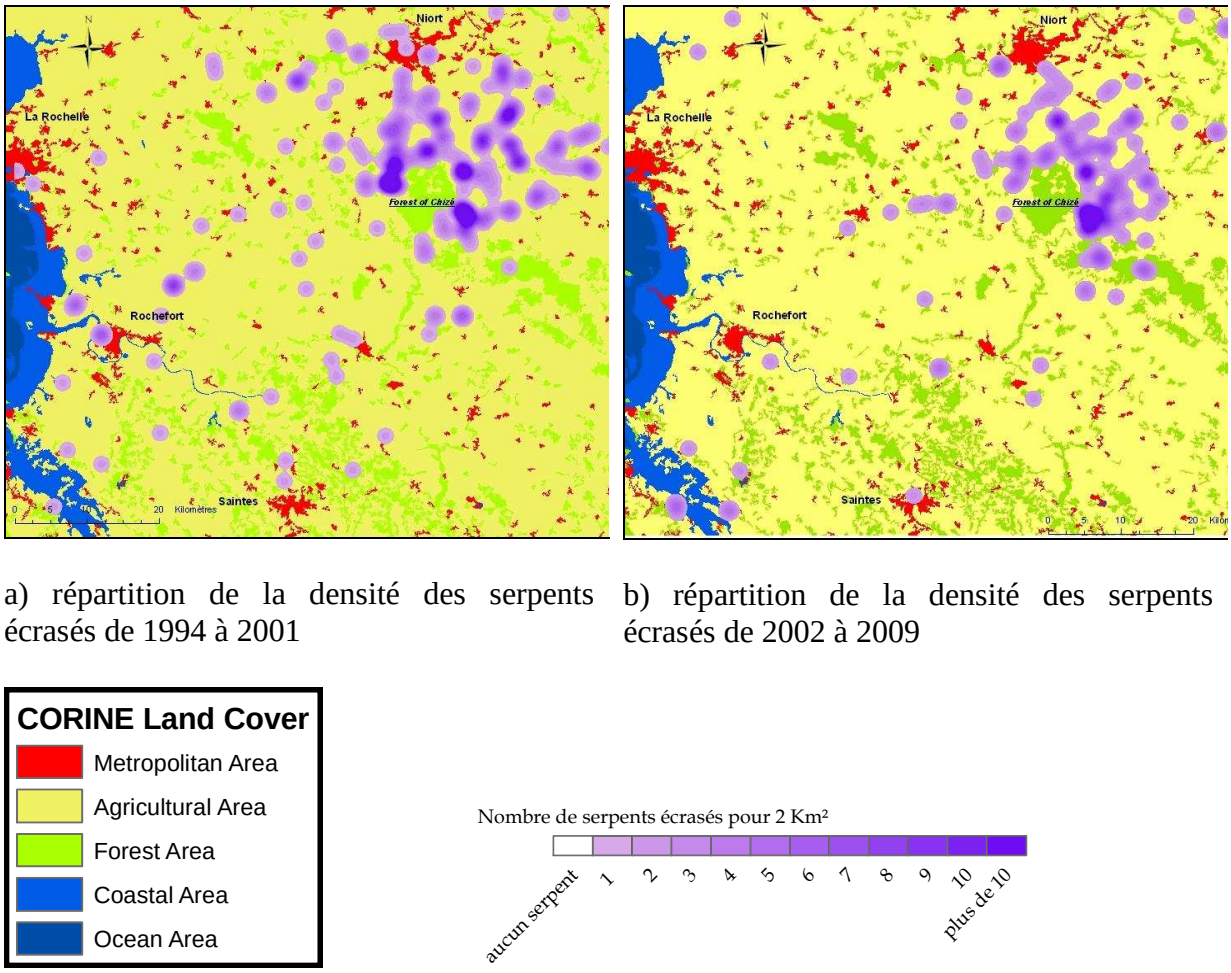
Quelles sont les causes du déclin des populations de serpents en France ?

Dans la continuité du constat du déclin généralisé des populations de serpents sur le plan mondial, nous nous sommes intéressés plus en détail aux populations de serpents suivies dans la région Sud Deux Sèvres (79). Dans cette région, les populations évoluant dans un milieu protégé (RBI) sont stables alors que celles évoluant à l'extérieur déclinent depuis 15 ans (article 5). La dégradation de l'habitat, notamment dû au développement d'une agriculture intensive et à l'urbanisation (routes, lotissement…) est l'hypothèse privilégiée pour expliquer le déclin des populations de serpents (en particulier celui de la couleuvre verte et jaune *Hierophis viridiflavus* et de la couleuvre d'Esculape *Zamenis longissima*).

Pour tester cette hypothèse, nous nous sommes intéressés à la localisation des serpents retrouvés écrasés depuis 1994. Alors que plus d'un millier de serpents ont été collectés, nous avons pu localiser 612 individus (sous SIG, ArcGis 9.3) principalement dans un rayon de 50 km autour de la forêt de Chizé (Figure 1). La majorité des serpents écrasés sont des couleuvres verte et jaune (57.8% des individus) et des couleuvres d'Esculape (30.8%). La cartographie et l'analyse de l'habitat ont été effectuées à partir des données paysagères fournies par le système CORINE Land Cover. Les serpents ont été localisés selon trois catégories d'habitats (forestier, agricole et urbain). La densité des serpents écrasés dans la région a été mesurée par la méthode de Kernel en adoptant une surface de 2 Km^2 qui correspond à la taille moyenne d'un domaine vital des serpents étudiés. Pour des besoins analytiques, nous avons divisé la période d'étude en deux sous périodes de 7 années chacune ; en effet, le nombre insuffisant de données sur un territoire aussi vaste ne permet pas une analyse annuelle.

Entre les deux périodes de 1994-2001 (n=276) *versus* 2002-2009 (n=183), le nombre de serpents écrasés a diminué de 30%, alors même que l'effort de prospection a augmenté. Les données concernant la forêt de Chizé, épargnée par la destruction de l'habitat ne sont pas prises en compte dans ce calcul. La répartition des serpents lors de la seconde période est moins homogène que lors de la précédente (Figure 1a et 1b). Des noyaux denses de serpents ont ainsi disparu au

nord de la forêt de Chizé. Certaines zones paraissent donc plus touchées, les populations ne subsisteraient donc plus que dans quelques zones encore préservées (près de la forêt de Chizé). Au niveau de la route très fréquentée reliant Niort à Beauvoir sur Niort, le phénomène est très visible (lors de la période 1994-2001, 20 observations ont été effectuées, alors que de 2002 à 2009 seulement 3). Cette route a subi de forts aménagements, arrachage des haies, construction de ronds points tandis que les alentours se sont fortement urbanisés (lot résidentiel, nouvelles usines…).



a) répartition de la densité des serpents écrasés de 1994 à 2001

b) répartition de la densité des serpents écrasés de 2002 à 2009

Figure 1 : Répartition de la densité des serpents écrasés dans la région Sud Deux Sèvres (79) de 1994 à 2001 (N=276) a) et de 2002 à 2008 (N=183) b).

Figure 1: *Density of snake observations in the area south of the Deux Sèvres (79) from 1994 to 2001 (N=276) a) and from de 2002 to 2008 (N=183) b).*

La répartition des serpents selon l'habitat a aussi été calculée pour trois périodes (1994-1998, N=265 ; 1999-2004, N= 195; 2005-2009, N=152) afin d'obtenir une

meilleure définition temporelle. La diminution du nombre de serpents écrasés au cours de ces trois périodes est nette et touche les trois types d'habitats, le milieu forestier où une diminution des effectifs de 14.7% est observée, mais encore plus le milieu urbain avec -22% et le milieu agricole -19% (Figure2).

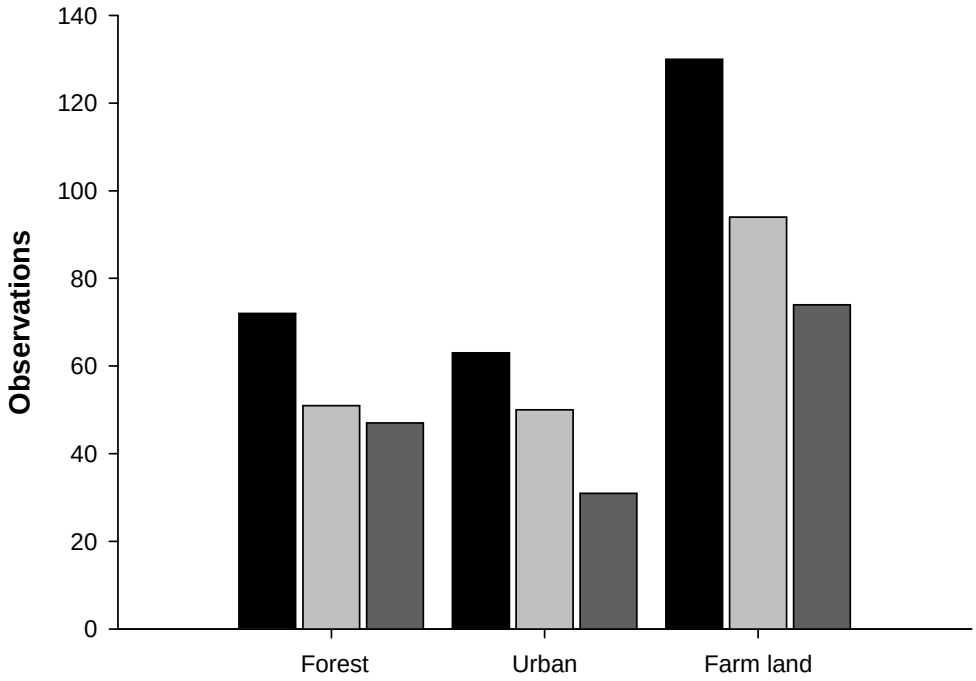


Figure 2 : Répartition des observations de serpents écrasés (N=612) dans trois types d'habitats (Forestier, urbain, et agricole) selon trois périodes (1994-1998, N=265, barres noires ; 1999-2004, N= 195, barres gris-claires; 2005-2009, N=152, barres gris-foncées).

Figure 2*: Number of observation of road killed snakes (N=612) in three kind of habitat (Forest, Urban, and Farm land) according to three times periods (1994-1998, N=265, black bars; 1999-2004, N= 195, grey bars; 2005-2009, N=152, dark grey bars).*

Bien que certaines zones semblent encore servir de refuges aux serpents, leurs populations déclinent de façon alarmante dans différents types d'habitats. L'une des raisons pourrait être la conséquence de l'écrasement des individus reproducteurs depuis plusieurs années qui affecterait le renouvellement des individus (Bonnet et al. 1999 ; Shine and Bonnet 2009). Il a été montré que ces animaux se faisaient principalement écrasés lors de la saison de reproduction, lorsque les mâles se déplacent à la recherche de femelles et lorsque les femelles vont chercher des sites de

pontes (Bonnet et al. 1998). La nette disparition des serpents dans le milieu urbain et agricole est probablement la conséquence de la disparition des habitats favorables (haies, prairies, murets….) ou encore de l'utilisation de pesticides (néfaste pour les proies). Les sites de pontes sont également des éléments clés pour la viabilité des populations de serpents. Par exemple, dans un vieux mur en pierre en milieu péri-urbain, depuis 2007, 73 femelles adultes différentes y ont été capturées et 85% d'entre elles étaient gravides (Figure 3). Malheureusement de telles constructions disparaissent aujourd'hui au profit du béton et du parpaing. Les conséquences sur les populations qui en dépendent sont donc probablement désastreuses.

Figure 3 : Muret en pierre sèche abritant chaque année de nombreuses femelles de serpent reproductrice, Chizé (79).

Figure 3: *Wall with dry stones with many reproductivively active snake females.*

Des sites de pontes, des ronciers et des plaques pour favoriser les populations de serpent et réaliser des actions d'éducations

La restauration d'un habitat favorable peut donc être un moyen de pallier la disparition des serpents. Nous avons tenté de mesurer l'efficacité des aménagements tels que les sites de pontes artificiels et l'entretien d'un milieu semi ouvert plutôt que la futaie (cf. Méthodologie).

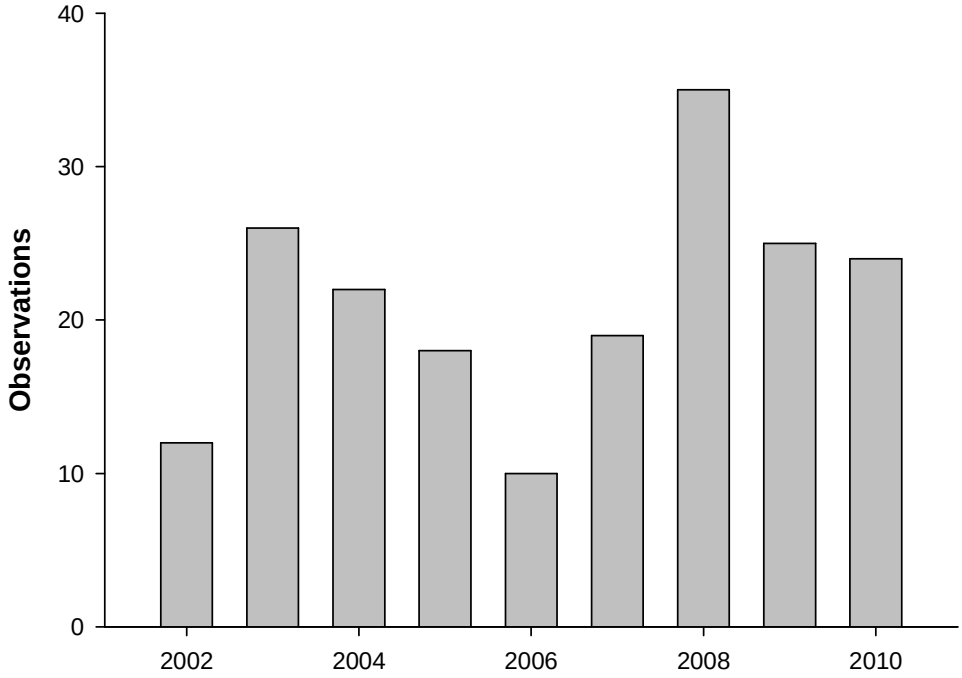


Figure 4 : Nombre de serpents capturés dans les trois sites de pontes artificiels de la RBI depuis 2002.

Figure 4**:** *Number of snakes caught in the three artificial nesting sites situated in the RBI since 2002.*

Sur les trois sites de pontes installés dans RBI de Chizé depuis 2002, au total 200 individus des trois espèces (*Hv*, *Zl* et couleuvre à collier *Natrix natrix*) ont été capturés. Les sites ont rapidement été utilisés par les serpents dès le premier printemps quelques jours après leur installation (Figure 4). Ces sites sont utilisés par les adultes qui constituent l'essentiel des captures (69 femelles, 107 males, et 24 juvéniles) et particulièrement par les femelles gravides (54% des femelles capturées *vs* 34% dans tout le reste de la forêt). Certaines ont d'ailleurs été observées plusieurs

années consécutives. Les sites de pontes artificiels semblent donc bien jouer leur rôle. Ils peuvent donc être des éléments efficaces pour pallier la disparition des sites de pontes naturels et également limiter l'écrasement des individus qui doivent se déplacer. Ils sont aussi des refuges au cours de l'hibernation grâce au fort effet de stabilisation des températures (Shine and Bonnet 2009).

Suites aux opérations d'entretiens des zones broussailleuses sur le site de l'Arche de la Nature, le nombre de serpents, principalement des vipères aspics (*Vipera aspis*) a considérablement augmenté au fil des années (figure 5). Bien que le statut de référence des populations n'ait pas été réalisé avant les opérations d'aménagement, les résultats suggèrent leur efficacité. La partie plus expérimentale de cette action, montre que le traitement en faveur de la strate arbustive est le facteur principal de la colonisation des milieux par les reptiles. Dans les habitats ayant subit des modifications futaies-haies, après un an 65 captures ont été réalisées, alors que dans les zones contrôles non modifiées (futaies), aucune capture n'a été faite.

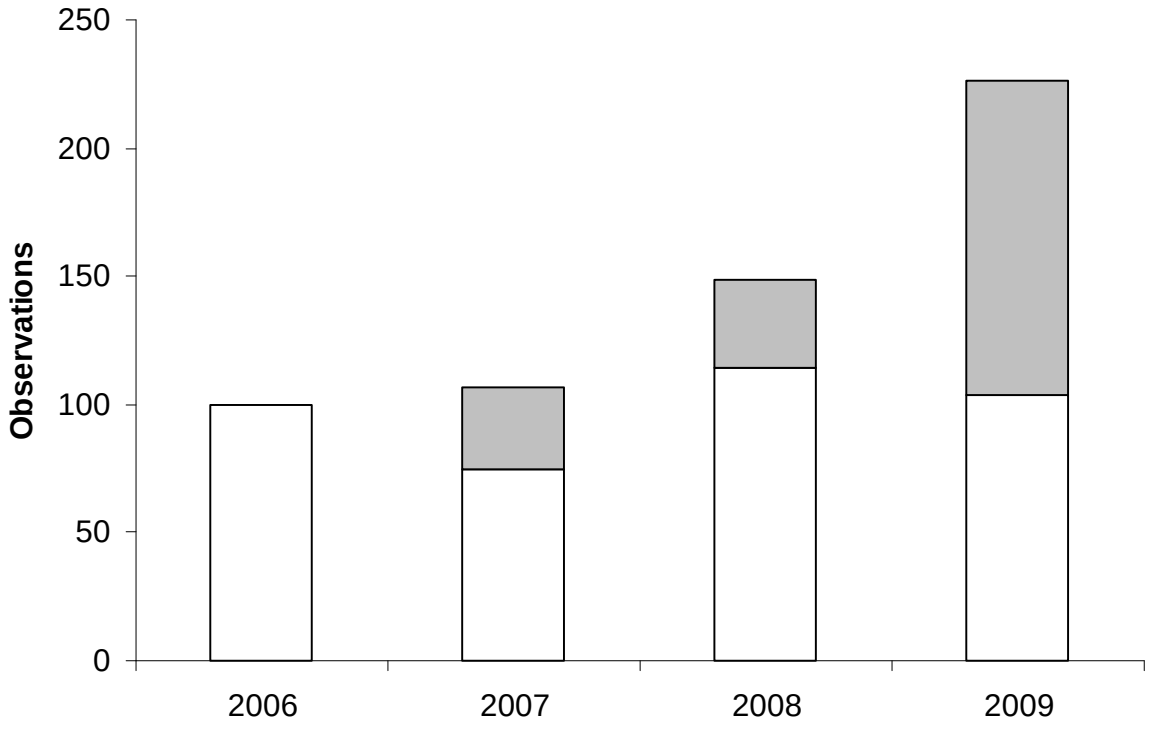


Figure 5 : Nombre de vipères aspics capturées (barres blanches) et re-capturées (barres grises) sur le site de l'Arche de la Nature suite à des opérations d'entretiens.

Figure 5*: Number of Aspic vipers captured (white bars) and recaptured (grey bars) after field management in the "l'Arche of Nature"site.*

L'ensemble de ces résultats montrent que des aménagements simples et peu coûteux peuvent être utilisés efficacement pour favoriser les populations de serpents. Mais de telles actions relèvent actuellement d'initiatives individuelles. Aussi la formation des gestionnaires et l'éducation des futurs citoyens sont nécessaires pour étendre ces initiatives. Grâce aux aménagements réalisés, de nombreux stages, destinés à la formation de gestionnaires ont ainsi pu être réalisés (Table 1). Ces sites ont également été des moyens efficaces de sensibilisation du grand public et des élèves à la préservation des serpents de la région.

Table 1 : Nombre approximatif de participants aux formations et sensibilisation réalisées depuis 2005.

Table 1*: Approximate number of participants involved in "snake education and training"*

FORMATION	**Nombre approximatif de participants (depuis 2005)**
ONF (Office National des forêts)	150
ONEMA (Office National de l'eau et des milieux aquatiques	100
ATEN (Atelier Technique des espaces naturels)	50
MI et MII, universités de Poitiers, La Rochelle, La Roche sur Yon, Angers	> 500
BTS (Gestion et Protection de la Nature)	150
IUT (Hygiène, Sécurité environnement)	250
Conseil Général de l'Hérault	3
EDUCATION-SENSIBILSATION	
Education scolaire	
primaire et collège (Cp à 6 ème)	650
Sensibilisation du grand public	
APIEE (Association Agréée de Protection, d'Informations et d'Etude de l'Eau et de son Environnement)	350

NB : Ce travail a été possible grâce à l'ONF, (Daniel Barré), l'Arche de la Nature, (Mélanie Papin, Grégory Provost, et Jean Luc Lassey) et l'inénarrable Rex Cambag .

5 Synthèse et perspectives

L'homme ne s'est jamais autant soucié de la préservation de l'environnement que depuis ces dix dernières années. L'enjeu est crucial et le public est considéré comme un acteur incontournable. Les médias et l'éducation scolaire sont aujourd'hui des éléments à part entière de la sensibilisation à l'environnement. Mais sommes-nous prêt à protéger l'ensemble des espèces vivantes ? Est-on en mesure d'agir de façon efficace ? Les réponses à ces questions sont généralement peu encourageantes. Pour la grande majorité, les citoyens ont une vision très limitée voire inexistante de la biodiversité comme l'a montré un sondage récent (Le Monde, Gregoire 2010), coupant net les possibilités de préserver notre patrimoine vivant à travers une démarche participative. Les jardins, qui presque toujours se résument à des mètres carrés de gazon bien arrosé et bien raz, montrent que nous ne protégeons à peu près rien, ce qui ne pique pas, ce qui n'envahit pas, ce qui semble propre ; quelques plantes ornementales ne compensent pas les dommages écologiques. Favoriser la biodiversité ne consiste pas uniquement à mettre un nichoir dans son jardin. Il faut que l'homme ait une perception plus large et respectueuse de la nature qui l'entoure. Les ronces, les broussailles, les murets abandonnés, ne doivent plus être considérés comme des pestes mais comme le berceau d'une biodiversité à protéger. Une des pistes les plus sérieuses est théoriquement de mieux expliquer aux nouvelles générations qu'il est souhaitable de ne pas créer des cimetières et des déserts (même engazonnés) par tous les moyens possibles.

La faible considération pour l'éducation à l'environnement (EE)

Malgré son importance déclarée, l'EE est un domaine qui bénéficie en pratique de faibles considérations scientifiques. La place des journaux spécialisés, un des meilleurs indicateurs en sciences, sur les études en EE en témoigne. Le facteur d'impact (IF) moyen pour ce genre de revue est de 0.1, ce qui est très bas, y compris par rapport aux revues de conservation qui dépassent souvent 1.0 (e.g. Conservation Biology >4.5). En gros, les revues d'EE sont moins de dix fois moins cotées que les revues de conservation. Une seule revue de science de l'éducation, Journal for Environnemental Education atteint péniblement un score de 0.4, ce qui reste

modeste. La plupart des autres revues sur le sujet ne sont tout simplement pas indexées, ce qui veut dire qu'elles ne sont pas beaucoup lues, quelle que soit la qualité de leur contenu. Par ailleurs, les chercheurs et les étudiants n'ont pratiquement aucun intérêt à publier dans les revues d'EE. De ce côté nous sommes plus ou moins dans une impasse. Heureusement que les revues de conservation acceptent des articles d'EE, mais en toute petite quantité.

Pendant cette thèse, j'ai eu l'opportunité de présenter mes travaux lors du congrès annuel de la société Européenne de Biologie de la Conservation (ECCB 2009). La place de l'EE était on ne peut plus discrète. Parmi une moyenne de dix sessions par jour pendant quatre jours, une seule session bien distincte des autres était prévue le dernier jour, un samedi, et histoire d'assurer les plus faibles chances de recevoir une audience importante, programmée en fin de journée. Peut être aurait-il été préférable de déguiser cette présentation avec un costume de changement global afin d'obtenir la salle principale, deux sessions par jour, des petits fours, des hôtesses, et la participation de Rex Cambag ? Peut être aurait-il fallu présenter des modèles mathématiques complexes sur « l'impact d'un nouvel agencement spatial des médias électroniques sur les attitudes fonctionnelles et adaptives des politiques de conservation » ?

La nécessité d'évaluer l'éducation

La popularité des organismes médiatisés, peut brider et limiter le nombre d'espèces à protéger (Kellert and Westervelt 1984 ; Tisdell et al. 2006). En effet, selon Coursey (1998), les préférences humaines pour les grandes espèces charismatiques ont fortement déséquilibré la distribution des ressources pour la conservation, (Maresova and Frynta 2007). Les attitudes anthropomorphiques jouent donc un rôle extrêmement important dans la conservation des espèces (Morris and Morris 1966 ; Kellert and Westervelt 1984).

Dans un contexte qui évolue vite, dans lequel les messages de conservation passent avant tout par les médias, et où l'influence des technologies est de plus en plus présente, l'un des premiers enseignements de cette thèse est qu'il est indispensable d'évaluer l'impact des différents types de programmes d'éducation.

Pendant longtemps, les méthodes et les techniques à mettre en place pour accomplir la mission d'EE n'ont pas été claires, et en fait nos investigations bibliographiques montrent qu'elles ne sont toujours pas passées sous les fourches caudines d'une évaluation statistique, ce qui est vraiment regrettable (Morgan and Gramann 1989). Il est donc important de disposer d'outils d'évaluation. Par soucis d'efficacité, et pour étendre au maximum les investigations, l'utilisation de questionnaires standardisés est primordiale.

Bien que ce manuscrit ne présente pas l'ensemble des résultats qui auraient pu être extraits du questionnaire, des objectifs importants ont été atteints. Certains diront peut être que ces résultats ne sont pas nouveaux, qu'ils sont une évidence. Mais en l'absence de mesures concrètes et d'analyses rigoureuses comment dériver des conclusions solides, comment tirer honnêtement la sonnette d'alarme ? Comment convaincre ? Les prises de positions basées uniquement sur des discours ou pire des idées reçues finissent généralement par ne plus être prises au sérieux et sont vouées à l'échec sur le long terme.

L'école pour sortir les enfants d'un environnement virtuel : un constat alarmant

Le premier constat apporté par cette étude est plutôt alarmant, les connaissances que les enfants ont de la biodiversité sont terriblement limitées. De façon préoccupante, les enfants ne connaissent pas les animaux qui les entourent (Lindemann-Matthies 2002 ; 2006) et sont déconnectés de leur environnement immédiat. Pourtant les enfants sont largement capables de retenir le nom des espèces et de les reconnaitre. Mais cette capacité existe bel et bien, elle est détournée en leur faveur par les marchands de toute sorte ; les enfants retiennent le nom et les caractéristiques de Pokémons qui leur sont vendus une fortune (Balmford 2002), et ils mémorisent des milliers de logos de produits ou de compagnies marchandes (Orr 2002). Visiblement l'école est impuissante à éviter que la tête des écoliers ne se remplisse d'autres choses que des publicités qui les assaillent à la maison et sur les trajets ; et l'encouragement à mettre davantage les enfants devant les écrans pendant les heures scolaires, ou à accepter des sponsors trop visibles n'est certainement pas une bonne solution.

Pour la conservation de la biodiversité locale, cette vision est décourageante. L'éducation à l'environnement doit pallier cette méconnaissance. Pour se situer dans une démarche participative, les futurs citoyens doivent avoir une représentation de la biodiversité qui couvrent l'ensemble des organismes et non pas quelques espèces charismatiques éventuellement affublées du logo de la compagnie qui les a prises pour emblèmes.

L'utilisation des animaux charismatiques n'est pas une panacée

Les enfants sont susceptibles de développer un intérêt et une affectivité forte envers des animaux, que les adultes en général négligent ou détruisent. Cette étude a notamment démontré que beaucoup d'enfants déclarent et démontrent aimer les serpents (un des animaux supposé les moins populaires… par les adultes !) au même titre que des pandas et autre ours. Développer un lien entre les enfants et une large diversité d'organismes ne semble donc pas présenter de grandes difficultés – contrairement à ce que prétendent trop de soi-disant experts. Ceci, d'autant plus que les enfants peuvent largement prendre leur responsabilité vis-à-vis de la protection des espèces : devant le choix cornélien de sauver une espèce populaire (félin, lapin) *versus* non populaire (poisson, insecte), les enfants choisissent celle qui est la plus menacée d'extinction, ils ne se laissent pas dominer par des préférences esthétiques (données non publiées d'une expérience que nous avons réalisée en 2009-2010). En pratique, leur envie de sauver les deux espèces les a régulièrement conduits à tricher avec les règles du jeu ; les biais taxonomiques en conservation crées par les adultes ne semblent pas régner en maitres chez les enfants.

Mais encore faut-il intéresser les enfants aux espèces pour lesquelles il est utile de réaliser des progrès. Il est évident que viser les espèces déjà aimées ou bénéficiant d'une forte popularité reviendrait partiellement à tourner en rond. Tout comme il devient un nouvel organisme de recherche en biologie évolutive (Shine and Bonnet 2000), le serpent pourrait tout à fait être un « nouvel organisme d'éducation ». Contrairement aux idées reçues et réticences largement exprimées au début du projet, les changements d'attitudes des enfants à leur égard se sont facilement réalisés.

L'éducation avec les serpents donne l'opportunité de réaliser des changements d'attitudes conséquents (Kaplan 1997). Parce qu'on part du plus bas (environ 40% des enfants déclaraient quand même ne pas aimer les serpents en début de sondage), ces changements d'attitudes pourraient vraisemblablement bénéficier aux organismes qui sont situés à un niveau plus haut sur l'échelle de la connaissance et des attitudes. Si le public désire protéger les serpents, il y a de forte chance pour qu'il désire protéger des espèces naturellement plus attractives ou moins détestées, comme par exemple les cloportes. En termes d'éducation et d'attitude le serpent peut, de cette façon, être considéré comme une espèce ombrelle. D'autres espèces telles que les araignées et les cafards pourraient sans doute jouer un rôle équivalent, dans la mesure où une approche basée sur le développement de l'affectif via l'expérience physique est favorisée.

Favoriser l'émotion plutôt que l'intellectuel

Que ce soit pour les espèces charismatiques ou les serpents, les enfants expriment un intérêt et un désir de protéger les animaux grâce à l'affectif qu'ils ont développé avec l'animal. Les résultats de cette étude vont exactement dans le sens d'études récentes qui soulignent l'importance primordiale du développement affectif de l'enfant pour développer des attitudes et des comportements positifs (Pooley and O'connor 2000 ; Hinds and Sparks 2008). L'EE ne doit donc surtout pas se résumer à faire ingurgiter aux enfants une somme de connaissance, ou à des visites de stations d'épuration, mais doit aussi transmettre des valeurs affectives grâce aux vertus des sorties de terrain au cours desquelles le vivant est manipulé et non pas simplement contemplé par exemple à travers des jumelles. La dimension affective, largement rejetée par le système d'enseignement, a reçu moins d'attention que la dimension cognitive (Prokop 2008). Il n'y a pas le mot « passion » ou équivalents dans les programmes officiels de l'éducation nationale. Le principal vecteur susceptible d'éveiller un développement affectif est pourtant l'émotion engendrée chez l'enfant. Les études en neurologie et psychologie vont exactement dans ce sens (Saunders 2003 ; D'Argembeau and Van der Linden 2004). De toute évidence, l'émotion ne naît pas grâce à des messages intellectuels (par exemple discours au sujet du rôle des

organismes dans l'écosystème). L'émotion naît grâce à des expériences fortes susceptibles de laisser des souvenirs impérissables (comme le fait d'avoir touché son premier serpent) (Figure 1).

Figure 1 : Contact « rapproché » entre une élève de CM1 et une couleuvre verte et jaune.

Figure 1: *Tight contact between schoolchildren and* Hierophis viridiflavus

La nécessité d'emmener les enfants sur le terrain

L'éducation sans composante expérimentale n'est probablement pas efficace (Kellert 1984 ; Knapp and Barrie 2001). Toutes les études convergent sur le fait que les expériences de terrain sont des vecteurs irremplaçables pour favoriser le développement affectif et l'émotionnel (Tanner 1980 ; Crompton and Sellar 1981). Nous avons précisément vérifié que cette approche a été très efficace avec l'un des animaux les moins populaires. Grâce notamment au contact de l'animal, des changements significatifs des attitudes des enfants se sont opérés. De toute évidence, de tels changements n'auraient pas eu lieu avec des discours où l'exposition d'animaux en terrarium. Tout aussi important, nous avons emmené les enfants sur le terrain, chez les serpents, et non pas l'inverse. Cette démarche est la condition *sine qua non* pour protéger des habitats. Les visites au zoo par exemple n'ont aucune chance de créer ce lien indispensable entre les espèces et leur milieu de vie. Grâce à

des expériences plaisantes, les enfants doivent avoir l'opportunité de mettre à contribution un maximum de sens, tactile, visuel, olfactif, et auditif (Moore and Cosco 2006). Ce contact joue un rôle extrêmement important dans le développement affectif de l'individu pour la nature (Cooper 1994 ; Chawla 1999 ; Kellert 2002). Outre sa valeur ludique, l'éducation sur le terrain est également indispensable pour l'apprentissage, car elle permet la perception des organismes et de leurs relations avec l'environnement (Ballantyne and Packer 2005 ; Zoldosova and Prokop 2006). Elle permet également aux élèves de visualiser concrètement les concepts écologiques et les connaissances acquises en classe (Manzanal et al. 1998 ; Hamilton-Ekeke 2006).

Favoriser les histoires naturelles plutôt que la propagande

L'approche par l'expérience permet à l'élève d'éliminer des représentations erronées *via* sa propre expérience, de contrer les idées reçues et les messages dogmatisés entre autres par les médias. Typiquement les serpents ne sont plus des monstres froids, cruels qui ne pensent qu'à tuer ; les enfants manifestent d'ailleurs clairement leur étonnement quand ils ont un serpent chaud et doux dans les mains. Cela contribue donc à favoriser l'esprit critique des enfants, base essentielle pour les rendre responsables et impliqués dans la conservation et de façon plus large dans la société.

Une des complications avec les sorties de terrain est que pour susciter l'intérêt des enfants et leur permettre de transférer des images abstraites en réalité, il est important de ne pas délivrer de message superficiel. Il faut pouvoir leur raconter des histoires basées sur une approche scientifique. L'observation d'un animal ne doit pas se limiter à donner un nom, elle doit aussi répondre à des questions et *a fortiori* raconter l'histoire naturelle de l'animal. Par exemple il faut répondre à des qestions du type « comment les serpents font des bébés ? » ; être capable de décrire l'animal en montrant s'il s'agit d'un mâle, d'une femelle, d'un individu reproducteur (ventre plain d'œufs…), en phase de mue, etc. Sans cela la capture des animaux ressemble à une coquille vide ; les enfants n'ayant plus de possibilité de raccorder leur propre vécu avec la vie de l'animal. De solides connaissances naturalistes et scientifiques sont donc indispensables pour générer de l'empathie et des émotions. Elles

permettent aussi à l'enfant de connecter l'animal avec son écosystème, site de ponte, broussailles, présence des proies (le campagnol étant vu dans les buissons et dans le ventre des serpents, ou sous la forme de restes dans les fèces…), et idéalement donnent des clés pratiques pour les protéger (e.g. ne pas détruire les broussailles…; Figure 2).

Figure 2 : Des élèves vont installer un refuge décoré pour les serpents.
Figure 2: *Schoolchildren are going to set up a customized shelter for snake.*

Favoriser le local

Souvent, la nature et sa conservation sont vues par le public comme « quelque chose qui se passe autre part », dans des parcs nationaux, des océans lointains, sur la banquise, des forêts primaires, des espaces sauvages. Il est donc important que les gens se rendent compte que dans la nature qui les entoure les mêmes processus écologiques, inclues ceux à la base des catastrophes spectaculaires, se produisent également, souvent à une échelle locale et moins visible (Miller and Hobbs 2002).
Pour que les enfants puissent s'impliquer dans la préservation de l'environnement, les actions d'éducation doivent se réaliser dans l'environnement familier des enfants. Il doit permettre aux enfants de signaler la présence sur le pas de leur porte d'une nature pouvant être spectaculaire et insoupçonnée. Le niveau local favorise

l'apprentissage par rapport à un environnement lointain, mais la réciproque ne semble pas vérifiée (Orion and Hofstein 1994).

Malheureusement l'utilisation de l'environnement immédiat des enfants n'est pas valorisée. Alors que les cours d'écoles sont des éléments clés pour engendrer des expériences (Wilson 1996 b; Moore and Cosco 2006) celles-ci sont de plus en plus aseptisées aussi bien en ville qu'à la campagne ; la « leçon de chose » ou équivalent est devenue une chose antique et désuète, remplacée par la recherche sur internet et l'apparition de superbes tableaux tactiles dans les classes. Système éducatif et parents d'élèvent applaudissent ce « progrès » – c'est réellement navrant. Pourtant, même les espaces périurbains, encore relativement préservés, sont des lieux à haute valeur éducationnelle. Les coûts et contraintes administratives liés aux transports scolaires ne sont pas si élevés pour que les enfants ne puissent jamais se rendre sur le terrain. La vérité est que les sorties sont considérées comme récréatives, périphériques aux objectifs centraux ; que les sorties réellement éducatives sont bien moisn estimées et aussi que le système ne propose rien. La majorité des enseignants sont complètement perdus sur le terrain.

Conclusion

La contribution principale de cette thèse est d'alerter en s'appuyant sur des valeurs statistiques de l'état de déréliction dans lequel se trouve l'éducation à l'environnement à l'école. Il est aujourd'hui plus que nécessaire que les enfants aient les clés pour adopter des démarches responsables envers la préservation de la biodiversité. Pour cela il est indispensable de créer un lien fort avec la nature et les êtres qui la composent. Les enfants doivent être les premiers ciblés, l'éducation doit leur permettre de leur faire découvrir la nature qui les entoure.

Trop souvent la biologie et l'environnement sont étudiés à travers des livres, des vidéos, des jeux, le suivi d'animaux par des moyens électroniques sophistiqués, des programmes en classe grâce à l'aide de spécialistes qui viennent à l'école avec des tas de documents et de trucs et bidules, des approches multidisciplinaires (e.g. les enfants dessinent les pauvres ours blancs à la dérive, font un petit calcul sur le

changement climatique… et exécutent des danses incantatoires…). Que de contorsions avec peu d'actions.

L'une des principales difficultés pour espérer remédier au manque d'éléments concrets et réels dans l'EE à l'école est probablement due à la prépondérance de l'approche intellectuelle : il est tout simplement plus facile de dire les choses que de les faire (Figure 3). Ce sont avant tout des valeurs émotives et une passion qui doivent être transmises plutôt que des valeurs écologiques conceptuelles et intellectualisées sans être palpables (Figure 1). D'autre part, la perception de la biodiversité par les enseignants est également un frein. Elle est souvent perçue comme très vague (données non publiées). Les rares enseignants qui organisent de véritables sorties de terrain sont comme par hasard ceux qui ont des connaissances naturalistes (Ballouard 2005). L'organisation de quelconques activités à l'extérieur de l'école engendre certes des difficultés (administratives, financières, coûts de transports, manque de temps), mais aucune n'est insurmontable – tout dépend des priorités. Par exemple, il n'existe pas de formation en EE très clairement orientée sur les liens pratiques et étroits (mot très suspect !) qu'il faut mettre en jeu entre sciences, une ou quelques espèces (et surtout pas un écosystème en entier) et le registre émotionnel des enfants. Au contraire, les approches holistiques, partenariales, transdisciplinaires, etc. sont préconisées. Il est demandé de tout (mal ?) faire et de ne pas s'intéresser à un sujet précis trop longtemps – c'est probablement une erreur de base. La capacité à avoir une vision élargie ne s'acquiert qu'après de très longues années de pratique et de recherche, chose impossible avec quelques heures annuelles prodiguées à de jeunes enfants. Par conséquent l'éducation à la biodiversité est mal fichue – ce que démontre incontestablement notre étude et toutes celles qui ont fait des recherches sur ce sujet - et elle reste bridée à ce qui se passe en classe, ou au mieux se résume à une sortie dans l'année au centre de tri des déchets (Orion and Hofstein 1994 ; Martin 2003). La formation des enseignants est donc l'une des clés de cette réussite, elle doit leur permettre de pouvoir éduquer les enfants à la biodiversité.

D'une façon globale, cette étude est encore à un stade préliminaire et d'autres questions doivent encore être examinées. Les données accumulées auprès de plus de 2500 élèves dans les dix pays enquêtés constituent toutefois une première source

solide d'informations. Une approche comparative entre pays, contextes socio culturels…pourra par exemple donner un meilleur témoignage de la perception des enfants vis-à vis de la biodiversité et ainsi nous donner peut être de meilleurs outils pour enrayer son déclin.

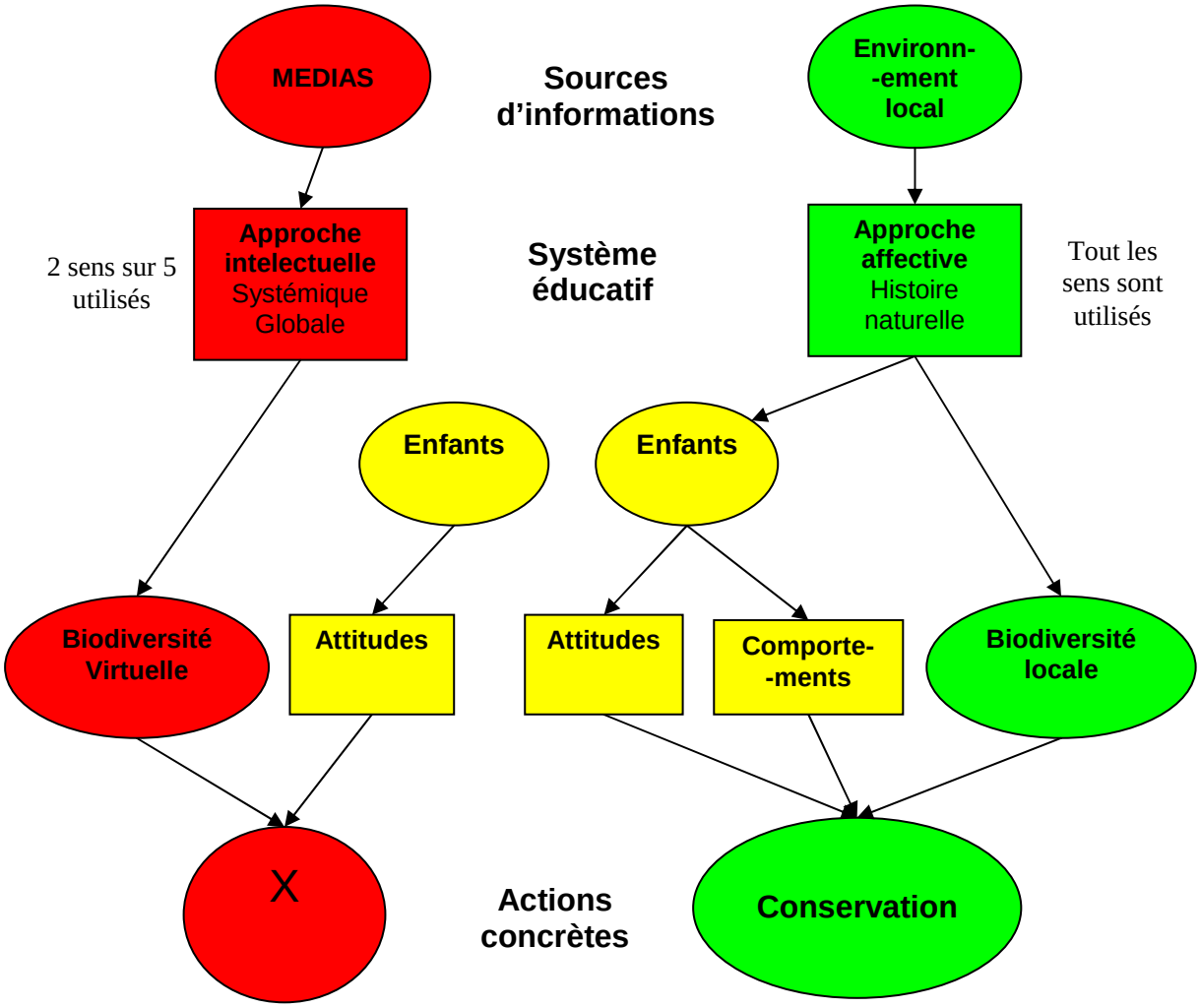


Figure 3 : Deux systèmes d'éducations basés sur :

1- une approche inefficace pour la conservation, intellectuelle et virtuelle se basant sur des informations provenant en grande partie des médias favorisant des attitudes positive mais limité à une biodiversité virtuelle.
2- Une approche efficace pour la conservation, basée sur l'environnement local et le développement de l'affectif qui favorisent à la fois des attitudes et des comportements positifs envers la biodiversité locale.

Figure 3: *Two educational system based on: 1- intellectual, virtual and inefficient approach ; 2-An efficient approach based on local environment.*

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7 Annexes

Questionnaires

Conservation & Education: life in the scrubs

Introduction

Teacher's guideline

Questionnaires for the pupils (general & snakes)

Questionnaire for teachers

Method to fill in the data file

Preliminary results

Firstly, we warmly thank you for your participation.

Introduction

Facing the increasing rate of loss of biodiversity, education has been identified as a priority. It has been clearly shown that to be efficient, educational programs should place the pupils into field situations designed to discover, respect and protect wildlife (Lindemann-Matthies 2002; 2006). Unfortunately, they are very few practical opportunities for such actions; most of the education activities about environmental problems are heavily based on the utilisation of books (Blumtsein and Seilan, 2007) And/or media. There are several potential consequences for such an absence of field experience for the children: the knowledge of the pupils about their own environment (e.g. wildlife living in their garden, country…) should be very limited. Children are likely more concerned by environmental problems well exposed by the media, for instance by few threatened iconic species usually from distant countries (e.g. tigers for European citizens).

The questionnaires are designed to test these hypotheses. We are particularly interested about the knowledge and preferences of the pupils for local versus exotic animals. We also aimed to identify some of the difficulties encountered by the teachers, and therefore requirements, to improve environmental education through practical actions. For instance, is it necessary to focus on few iconic species systematically presented by the media to run interesting educational programs? Alternatively, shouldn't we use local species to position educational activities within a real context (by opposition to a virtual perspective). Instead of maintaining the centre of attention around few birds and few mammals, shouldn't we focus also on unpopular organisms in order to encompass a wide spectrum of species? The simple questionnaires proposed here are the outcomes of the analyses we performed on larger and more comprehensive questionnaires. We hope that they will enable to assess the perception of the biodiversity by pupils.

In a second step, we organise short field excursions (1/2 day) revolving around snake studies in a natural context. Then, we address again the questionnaires for comparisons. Preliminary results are very encouraging.

Teacher's Guideline

The questionnaire is designed for young pupils (8-12 years old capable to write). During school time, broadly 30 minutes are required for the children to fill in the two questionnaires ("1 - general" and "2 - snakes"). If additional time is required, this is not a problem. The teacher can fill in the "teacher questionnaire" independently.

Before all, the teacher must provide several explanations (5-10 minutes maximum) and follow some recommendations:
The questionnaire should be shortly introduced as an enquiry performed in different countries to assess the perception and knowledge about biodiversity threats.
This is not an exam. Hence the children must feel comfortable to answer. There is absolutely no trouble if they cannot answer to some questions.
Limit the preliminary explanations about global problems regarding biodiversity; do not provide any precise example of threatened animal (otherwise the children will use it). Instead, limit the notion to the fact that animals, plants, wildlife in general are threatened. It is useful to explain what is Biodiversity and which different kinds of organisms are encompassed by the term "Animal". Indeed, it appeared that many children did not include insects or invertebrate and considered only vertebrates.
After the short introduction each children must work individually to fill in the questionnaire. Of course, pupils can question the teacher for further explanations. This is important, notably if the questionnaire is not clear to the children (we do not claim that we totally succeed to write clear questionnaires). However, we insist again about the fact that the teacher must not provide precise example, names, etc. If the children do not understand the instructions, one possibility is to illustrate a solution using plant names.
There are two questionnaires: a first one very general (3 pages), and a second one about snakes (2 pages). It is important to not say that the second questionnaire is about snakes (otherwise the kids will think heavily about these animals). When the first questionnaire is finished; then the second one on snakes can be distributed.

The plate with the pictures of the animals must not be given at the beginning; otherwise this will strongly influence the children. Therefore, this plate must be given exactly when the pupils have finished the question 3 page 2.

Further explanations about the questionnaires:

Questionnaire general

Every time, the children should try to provide the most precise animal's name. For instance, "blue-tit" is more precise than "bird". Of course, "fish" or "insect" although quite imprecise are perfectly acceptable.

There are several redundancies between the questions; this is because they do not address exactly the same problem. This means that the same animal can be proposed in different occasions. For instance, if a child observed a rat in his garden, and think that this species must be absolutely protected, then he will put the name "rat" in the two lists page 1 and 2. Conversely, the pupil may prefer to put in the list 3 page 2 only exotic animals. This means that the list 3 page 2 ("List 5 animals that must be protected") is independent from the rest of the questionnaire.

The plate presents 20 animals selected to provide a balanced sample of local versus exotic species. Similarly, mammals, birds, reptiles, amphibians, invertebrates should all be represented. We fully realise that there is a strong bias toward vertebrates; but there is very little possibility to escape such a complication.

The teacher are the most capable to select the local species likely encountered by the pupils in their local environment. Therefore, we strongly encourage the teacher to use modify and to save the plates they will judge as the most appropriate.

Questionnaire snakes

This questionnaire can be used alone; or before and after a field trip focused on snakes. A presentation of living snakes at school can be also tested. When used before and after an experience with snakes, it is important to use control groups: a number of pupils tested only once after the practical experience.

Questionnaire (general)

1 -

Age	
Sex	
Class level	

Where do you live?

□ In a city

□ In a small village

□ In a house in the countryside

Do you have a garden? □YES □ NO

Is one of your parents a farmer? □YES □ NO

Do you think wildlife must be protected? □YES □ NO

2 - List wild animals that you have seen around your house, or during a walk… (Do not include animals observed in ZOO, pets or domestic species):

- - -
- - -
- - -
- - -
- - -

Do you think that all these animals must be protected? □YES □NO

If not, which one should not be protected?

- - -
- - -
- - -
- - -
- - -

3 – List 5 animals that must be protected:

Animal 1:……..…..

Where did you see it (magazine, TV, ZOO, in the field…)?……..

Animal 2:……..…..

Where did you see it (magazine, TV, ZOO, in the field…)?……..

Animal 3:……..…..

Where did you see it (magazine, TV, ZOO, in the field…)?……..

Animal 4:……..…..

Where did you see it (magazine, TV, ZOO, in the field…)?……..

Animal 5:……..…..

Where did you see it (magazine, TV, ZOO, in the field…)?……..

4 – Look at the pictures and fill in, as much as you can, the table below.

Picture number	Give the name of the animal	Have you ever seen it? (Yes/No)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Among the above animals, give 5 that must be protected (use numbers in the column, not names)

……

……

5 - Rank the animals listed below from the one you dislike the most (1) to the one you dislike the less (6).

Rat	
Bat	
Cockroach	
Snake	
Spider	
Slug	

Questionnaire (snakes)

Have you ever seen a snake? □ YES □ NO

Have you ever touched a snake? □ YES □ NO

Do you like snake? □ YES □ NO □ It depends
Why?……
……..

Are you afraid by snakes? □ YES □ NO
Why?……

Which species of snake do you know?
……
……

What are the names of the snake species that live in your country?
……
……

What do you know about the life of snakes?
……
……

Is it important to protect snakes? □ YES □ NO
Why?…… …… ……

Fill in the 2 tables below

Do you think that snakes are (or do)	Yes	No
Friendly		
Nasty		
Funny		
Wicked		
Satanic		
Useful to protect the garden		
Hypnotise their prey		
Suckle cows		
Attack human		
Beautiful		
Slimy		
Dirty		
Cold		
Useful for farmers		
Drink milk		
Ugly		
Clever		
Smooth		
Others		

If you see a snake	Yes	No
You avoid it		
You watch it		
You kill it		
You try to catch it		
You run away		
You call one of your parents		
You call one of your parents to kill it		
You ignore it		
Others		

PLATE

picture 1 	picture 2 	picture 3 	picture 4 
picture 5 	picture 6 	picture 7 	picture 8 
picture 9 	picture 10 	picture 11 	picture 12 
picture 13 		picture 15 	picture 16 
picture 17 	picture 18 	picture 19 	picture 20 

Questionnaire for teachers

Country	City	School

Location of the school:	Urban	Sub urban	Rural

Number of pupils in the class:	

What is your primary school training?

Sport, science, literature, economy, others……

Tick the followings

Preservation of the Biodiversity is a top priority

Preservation of the Biodiversity is important but not a top priority

Preservation of the Biodiversity is not important

Preservation of the Biodiversity is useless

If so, why do you consider that Biodiversity Conservation is important?

……

……..

Do you currently run an environmental program in your class? YES NO

In the past? YES NO

If yes:

What is (was) the exact topic?

……..

……

What kind of support do (did) you use (media, documents, books, Internet, live animals, environmental animators, field trip…)?

…….

…….

…….

This year did you organise a field trip with your pupils? YES NO

If so, where?……

If not, do you plan to organise one in the future? YES NO

If so, where?……

Do you raise animals in you class? YES NO

If yes, which ones?…… ……

Why?……

…… ……

Do you face difficulties to set up environmental education activities? YES NO

If yes, which ones?……

……

Were tools available to run the activities? YES NO

If yes, which ones?……

……

Provide 5 examples of animals that you wish to use to illustrate biodiversity problem

- - -

- -

Listes des articles en relation avec la thèse

Article 1 : **J.M. Ballouard**, X. Bonnet, S. J. Mullin, R. Ajtic, J. Brito, J. Crnobrnja-Isailovic, E.H. ElMouden, M. Erdogan, M. Feriche, J. M. Pleguezuelos, P. Prokop, A. Sánchez, X. Santos, T. Slimani, B. Sterijovski, L. Tomovic, M. Uşak, M. Zuffi. Factors influencing schoolchildren responses to conservation education questionnaires, *soumis*.

Article 2 : **J.M.Ballouard**, X. Bonnet and F. Brischoux. Which species do you want to protect? Virtual exotic biodiversity overwhelms local biodiversity, *soumis*.

Article 3 : **J.M. Ballouard**, X. Bonnet, R. Ajtic, H. Balint, J. Brito, J. Crnobrnja-Isailovic, D. Desmonts, E.H. ElMouden, M. Erdogan, M. Feriche, J. M. Pleguezuelos, P. Prokov, A. Sánchez, X. Santos, T. Slimani, B. Sterijovski, L. Tomovic, M.Uşak, M. Zuffi. Schoolchildren and the most unpopular species: are they ready to protect snakes? *En préparation*.

Article 4 : **J.M. Ballouard**, X. Bonnet. Short term effects of a field trip on schoolchildren' attitude toward an unpopular organism: an experience with snake. *En préparation*.

Article 5 : C. J. Reading, L. M. Luiselli, G. C. Akani, X. Bonnet, G. Amori, **J. M. Ballouard**, E. Filippi, G. Naulleau, D. Pearson and L. Rugiero. 2010. Are snake populations in widespread decline? *Biology letters* doi:10.1098/rsbl.2010.0373

Article hors thématique de thèse (Article 6)

Ballouard J.M, P. Priol, J. Oison, A. Ciliberti and A. Cadi. 2010. Does reintroduction stabilize the population of the Critically Endangered gharial (Gavialis gangeticus, gavialidae) in Chitwan National Park, Nepal? Aquatic Conservation: Marine and Freshwater Ecosystem 20: 756–761. DOI: 10.1002/aqc.1151

Does reintroduction stabilize the population of the Critically Endangered gharial (*Gavialis gangeticus*, gavialidae) in Chitwan National Park, Nepal?

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Aquatic Conservation: Marine and Freshwater Ecosystem 20: 756–761. DOI: 10.1002/aqc.1151

Abstract

1 - Despite conservation programs (India, 1975, Nepal, 1978) gharial populations (*Gavialis gangeticus*) decline over their entire distribution range. Information about the current status and main threats is needed to implement effective conservation measures.

2 - This study presents a survey (2003-2004) of the largest Nepalese gharial population in the Chitwan National Park that benefited from regular re-introduction of young gharials since 1981.

3 - Population size estimates fluctuate between 34 (2003) and 38 (2004). Reintroduction program, although poorly successful enable to maintain gharial population.

4 - Gharials bask preferentially in large sand banks, and these sites must be protected.

5 - The main threats are: - a) a dam that causes fish depletion and flushes gharials from protected area - b) sand mining and grazing that destroy basking sites - c) fishing that causes food shortage d) drift net that kill gharial - e) water pollution.

6- Improvement of the survival of reintroduced gharials is needed. Strict protection of preferred basking sites and prohibition of fishing in the main settling zones are the prior conservation measures. On the long term education and participatory management of local people are necessary.

Keywords: conservation, crocodile, endangered species, gharial, Nepal, reintroduction.

INTRODUCTION

The gharial (*Gavialis gangeticus* Gmelin, 1789), listed in 1975 in Appendix 1 by CITES (CITES, 2006), is now listed as Critically Endangered on the IUCN Red List (IUCN, 2007). Wild populations fluctuated in the last decade, and unfortunately exhibited a worrying decline. This species was formerly found throughout the Indian subcontinent, including rivers of Pakistan, Burma, Bengladesh, North India, Nepal and Bhutan (Whitaker and Basu, 1982). With only 250 to 300 individuals in the entire Ganges basin, the gharial was close to extinction in the 1970's due to human pressure (Grenard, 1991). The creation of protected wetland areas in conjunction with a reintroduction program of captive reared individuals undertaken in India and Nepal restored the population to approximately 1,500 individuals (Andrews and MacEachern, 1994; Hussain, 1999; Whitaker and Andrews, 2003). Despite conservation efforts, gharial populations remain fragile. For instance, in the largest gharial population in the world (National Chambal Sanctuary) numbers decreased by 40% between 1998 and 2007 (Hussain, 2009). In 2006, adult population size was estimated to be 200 individuals in India and 35 in Nepal. In the other countries, gharials are considered virtually extinct (Whitaker *et al.*, 2007).

The Gharial Conservation Project in Chitwan National Park (CNP, Nepal) was launched in 1978. Because neonate annual survival rate is very low under natural conditions (7.7%; Hussain, 1999), and because only 5.5% of hatchlings are recruited in the population (Hussain, 1999), a reinforcement program was setup. Eggs were collected in the field, artificially incubated, and the neonates raised during between 4 to 7 years before releasing (Maskey, 1989). From 1981 to 2007, 691 young specimens reared in captivity have been reintroduced, including 438 in the two main rivers of the CNP: the Narayani River; and the Rapti River (Forestry Nepal, 2008). In 1993, a survey performed in Nepal reported 58 wild gharials and 75 reintroduced (Maskey and Percival, 1994). In the rivers of the CNP 32 wild gharials and 20 introduced gharials were recorded, most of them on the Narayani river. The survival of the captive reared gharials in the Narayani was estimated at 7% (Maskey and Percival, 1994). Although the project is the only management program established to sustain

the gharial distribution in Nepal's rivers, its efficiency has been questioned (Maskey, 1989; Maskey and Percival, 1994).

Therefore, further conservation efforts are critical. The French-Nepalese collaboration initiated in 2001 at the Crocodile Farm of Pierrelatte (France) aimed to: 1. Examine the state of the gharial population 10 years after the last census in 1993; and 2. Determine the efficiency of the reintroduction program. Between 2002 and 2006, fifty six released gharials were monitored (Cadi et *al.*, 2002, 2005, 2008). For this study wild and released animals in the rivers of the CNP were counted in 2003 and 2004. This study presents results of the population distribution and ecological characteristics of preferred basking sites of the gharial in order to identify possible threats. The final objective of this study was to propose effective conservation measures to protect one of the most significant remaining gharial populations.

METHODS

Study site

The Narayani and Rapti Rivers delimit respectively the north and west boundaries of the CNP (83°50′ to 85°00′ E, 27°15′ to 27°40′ N). Both rivers are influenced by the subtropical climate of the Teraï region with two distinct periods, the monsoon (May to November, 80 % of the annual precipitation) and dry season (December to April). The Narayani is a powerful river (1000-1700 m3 s-1 in low water periods) that flows from the Himalayan hills. A dam at the Nepal/India border is used for irrigation and flood control. The Rapti River is smaller and confined to the Teraï plain. It relies on local rains and as a consequence is warmer than the Narayani (Maskey, 1989).

Five river segments (15-30km each) along a total 112 linear kilometres of river were studied (Fig. 1; Table 1). The last survey performed in 1993 indicated that most of the gharials were found in the Narayani River and its main affluent, the Kali Gandaki situated north of the park (more than 30 wild adult gharials in the Narayani and 9 wild individuals in the Kali Gandaki). At that time no wild gharials weres found in the Rapti River, although several individuals have been released there since 1981 (Maskey and Percival, 1994).

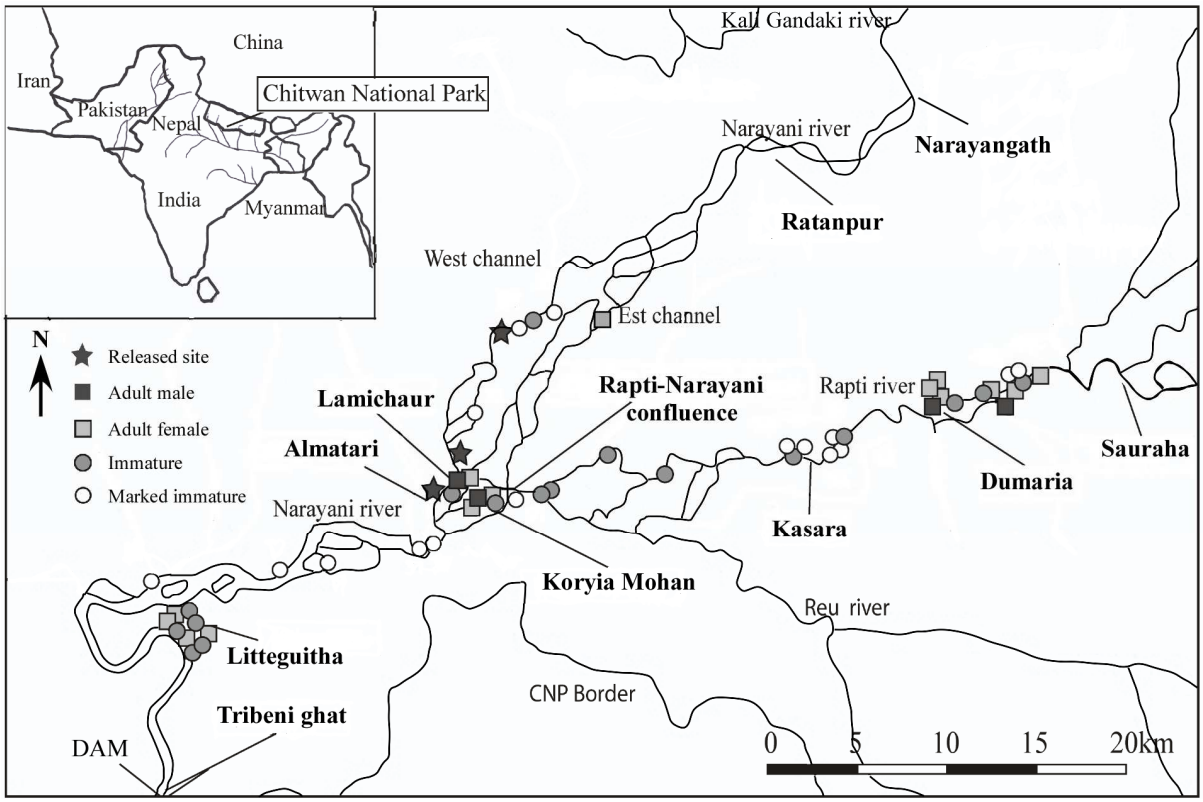

Figure 1: Study area and localisation of gharials in Chitwan National Park during the survey in 2004. The localisation of individuals does not illustrate their movement (see Table 2). Symbols show where individuals have been mostly sighted.

Table 1: Locality of the release site, number of reintroduced gharial in 2002-2003 and their observation in 2004 among the different segments of the rivers of Chitwan National Park

River	Rapti		Narayani			
Segment	Sauraha-Kasara (S-K)	Kasara-Rapti-Narayani Confluence (K-A)	Ratanpur-Amaltari West Channel (R-AW)	Ratanpur-Amaltari Est Channel (R-AE)	Amaltari-Tribeni (A-T)	TOTAL
Gharial reintroduced (2002-2003)			20 - 6		0 - 10	36
Observations	1	0	0	1	0	2
	0	1	0	0	0	1
	4	2	3	0	4	14
					TOTAL	16

The reintroduction program

Since 1981 gharial populations of the CNP have been dependent on annual reintroduction of young crocodiles. A major cause of the population decline in Nepal has been the flooding of nests caused by the damming of rivers which provokes abnormally high floods during heavy monsoon seasons (Maskey, 1989).

To allow hatchling survival and promote juvenile survival, eggs were removed from their natural environment and artificially incubated at the Gharial Monitoring Centre (CNP, Kasara). Mean clutch size of nests varied between 34.4 and 37.0 eggs (Maskey, 1989).The neonates were raised in captivity for 4 to 7 years until they attained on average a body size of 1.5 m (under this size, gharials have a low survival rate) before release (Maskey and Percival, 1994).

Since 1981, each year, immature crocodiles were reintroduced in the rivers. In this study, from March 2002 until November 2003, 36 gharials were released at 3 different times (Table 1). Released individuals were marked with cattle tags attached to a tail scale. Cattle tags remained attached at least 2 years after fixation, but it was possible to read the numbers for one year only. In addition, notches in the caudal scales enable to mark permanently the individuals (Fig. 2).

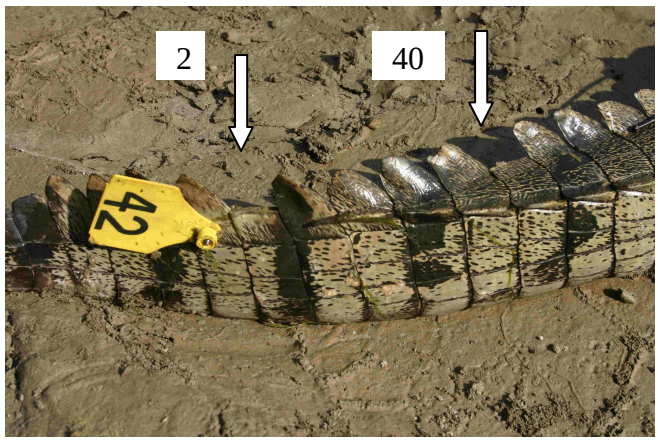

Figure 2: Mark on scales with cattle tags and notches on individual number 42 (see notches at the second vertical scale (number 2) and the fourth left horizontal scale (number 40)).

Population surveys

Surveys were undertaken during two different periods: 1) from November 2002 to April 2003, and 2) from November 2003 to May 2004. For each survey, the Narayani and Rapti Rivers were divided into five segments. Each segment was surveyed during the first (6 occasions) and the second period (7 occasions) for a total of 13 occasions. Two people on two kayaks surveyed each segment every two or three weeks. Binoculars were used to carefully observe the areas likely to host animals. The surveys were performed at the most appropriate time of day: from 10 a.m. to 4 p.m when the temperatures were cold (November to February air temperature ranged between 5 and 25°C), considered as the better period for census, and from 8 a.m. to 2 p.m. once temperatures increased (March to May air temperature ranged between 18 and 44°C) (Whitaker and Basu, 1982; Rao *et al.*, 1995).

To characterize age/sex classes we used the following criteria:

1- Gharials less than 2.8 m in total length (TL) were considered immature. Maturity is generally attained at a body size over 3 m, 13-14 years. This criterion is not absolute, and for instance an 18 years old male measured only 2.7 m (Singh, 1979; Hussain, 1999). This category includes gharial less than 2.20 m likely from previous release (2000-2002) and individual above 2.20 m likely from releasing (before 2000).

2- Individual above 2.8 m with a growth (ghara) at the tip of the snout (Biswas, 1977) were considered as adult males. This category also includes individuals above 2.20 m.

3- Individuals above 2.8 m without ghara were considered as adult females (Biswas, 1977).

These two last categories also included individuals above 2.20 m.

Population estimates included marked individuals released before 2002 (without permanent marking). The minimum size of the population was estimated via direct count. This number added: 1- best counting during the most favourable period (February) gharials seen were the highest; 2: plus additional individuals known to be present, but missed during the best counting.

The survey of reintroduced animals was performed in 2004 during the census of the wild population. The location of each observed gharial was recorded with a GPS (We admitted a precision of 50m because fixes were recorded from boat and from distance to not disturb the gharials).

Ecological characteristics of basking sites

For most crocodiles, the selection of appropriate basking sites on riverbanks is crucial for thermoregulation and to escape predation. For each basking site where gharials were observed, water depth classes (D1: < 1 m; D2: 1 – 2 m; D3: > 2 m) of the adjacent riverbed were measured. Basking habitat was classified into five categories: mixed bank, rock bank, sand bank, steep bank and sandy island (Maskey *et al*., 1995).
Mixed: composed of sand and rock and/or grasses (e.g. *Polygonum plebujum*).
Rock: consisted mainly of stones or pebbles ranging in diameter from 50 mm to 250 mm.
Sand: high bank of fine sand without or with little vegetation and less than 30 degrees slope.
Steep: more than a 30 degrees slope consisting of sand alone or with vegetation.
Sandy island: fine sand crossed by waterways.

RESULTS

Status of the wild population

Census

A total of 245 observations of wild gharials were made during the two survey periods in the CNP (116 in 2002-2003 and 129 in 2003-2004). It was counted 38 gharials in 2002-2003 (3 adult males, 12 adult females, 23 immatures (including 7 individuals <2,20 m)) and 34 in 2003-2004 (4 adult males, 13 adult females, 17 immatures (including 3 individuals <2,20 m)) were counted.
Figure 3 shows: 1) that the population of gharials (adult and immature) observed in the wild is low although gharials have been regularly reintroduced since 1983; 2) a

depletion of this population between 1986 and 2004. In 1993, the sex ratio was 1/10 (Maskey and Percival, 1994), but it is now of 1/4.

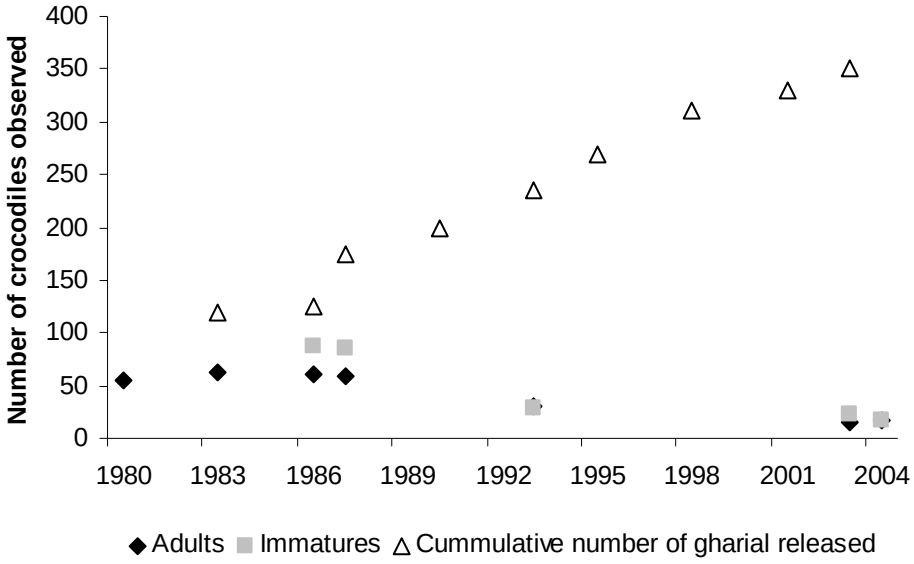

Figure 3: Crocodile population changes CNP, (according to Maskey, 1989; Maskey and Percival, 1994 and this study 2003-2004)

Distribution and density

Adults and immatures were homogeneously distributed in the Rapti and Narayani rivers. In both study periods, the highest concentrations of wild gharials occurred in the Sauraha-Kasara segment in the Rapti River (0.73 ind/km in 2003-2004) and in the Amaltari-Tribeni segment in the Narayani River (0.39 ind/km in 2003-2004). On the West Channel of the Narayani River, the gharial density decreased from 0.33 ind/km in 2003 to 0.16 ind/km in 2004. Similarly in the East Channel, the gharial density decreased from 0.33 ind/km in 2003 to 0.14 ind/km in 2004. Although gharials are scattered in these segments, their distribution is characterized by groups of animals on specific sites, particularly adults (Fig. 1)

Status of the reintroduced gharials

Survival

From two successive batches of marked reintroduced gharials, 10 in March 2002 and 26 in March-April 2003, 16 individuals were observed in 2004. Five individuals (50%) from the March 2002 batch were seen in 2003, but only 2 in 2004 (20%). From the March-April 2003 batch, 14 were observed in 2004 (54 %). Overall, 50% of the reintroduced gharials disappeared each year, suggesting a low success rate of reintroduction, at least the first year after release.

Distribution

The 16 reintroduced gharials observed in 2004 were observed on 59 occasions (3.7 observations per individual). The distribution of the gharial was homogeneous within the various segments of the park (Fig. 1). The 3 release sites were associated with three distribution patterns of the reintroduced crocodiles: 1. Scattering as far as 20 to 40 km from released site in the Rapti River in the Sauraha-Kasara segment 2. Settling near release site and 3. Settling up to 20 km downstream from the release site in the Narayani River.

Characteristics of basking sites

During the two survey periods, we recorded water depths in the vicinity of 211 basking sites and described the habitat on 295 occasions. Larger gharials (adults and immatures; TL > 2.20 m) tended to be observed basking close to waters deeper than 1 m (χ^2=17.32; df = 2; P<0.01) while smaller individuals (immatures including released individuals; TL < 2.20 m) were mostly observed close to shallow water (<1m) (χ^2= 5.85; df = 2; P > 0.05; Fig. 4a). Gharials preferred sandy banks to all other habitat types. Larger individuals were observed mostly on sandy riverbanks, more often than smaller individuals (χ^2= 234.88; df = 4; P<0.01). Smaller individuals also used sandy "islands" situated within the river more often than larger individuals (χ^2= 61.46; df = 4; P<0.01; Fig. 4b).

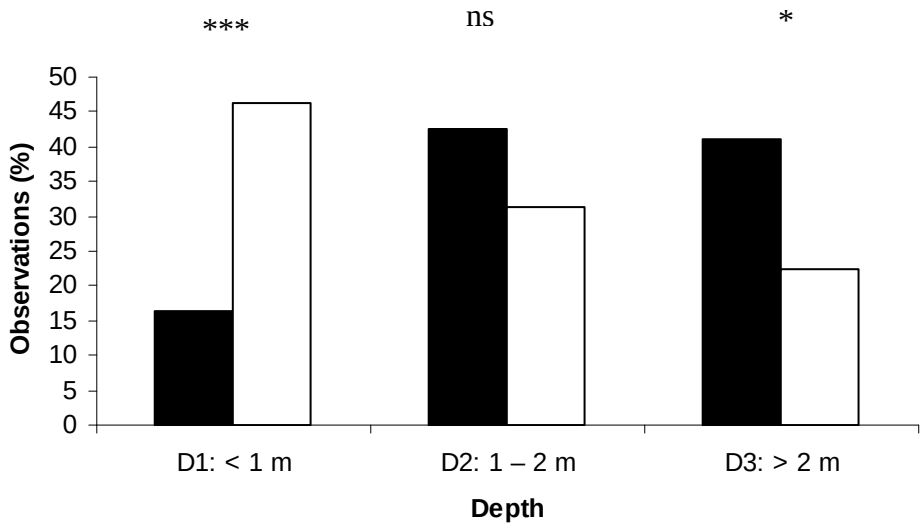

Figure 4a: Depth of water near basking sites of gharials (black bars: individuals > 2,20 m, white bars: individuals < 2,20 m, *** = P<0,001; ** = P< 0,01; * = P<0,05 see text for details).

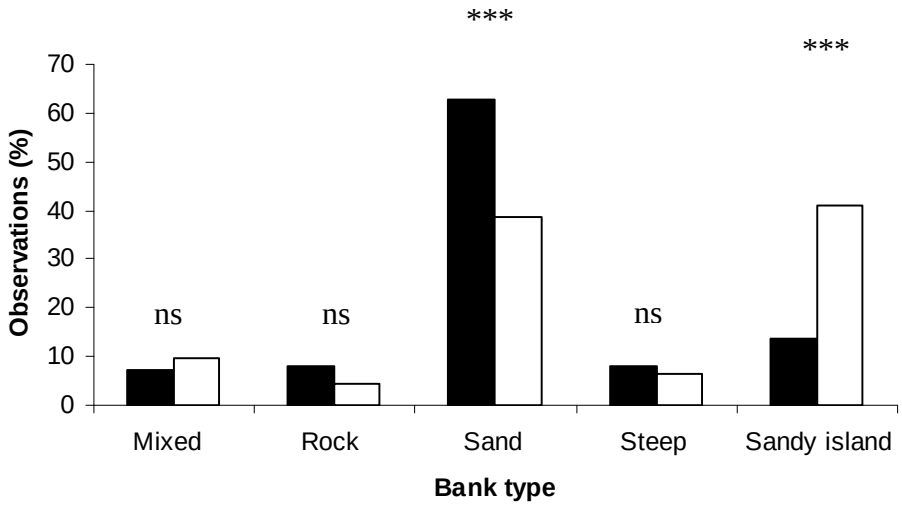

Figure 4b: Distribution of the basking site of gharials (black bars: individuals > 2,20 m, white bars: individuals < 2,20 m, *** = P<0,001; ** = P< 0,01; * = P<0,05 see text for details).

DISCUSSION

Population status

Data from the current study, and those from recent surveys (Forestry Nepal, 2008) suggest that the gharials of CNP represents the main population of Nepal, the third largest in the world; however it is extremely vulnerable. Long-term studies are needed to propose effective conservation measures and to provide a scientific basis to improve political support. Although the total number of individuals within the CNP, approximately 50 (Wild + released), appears to be stable, the low success rate of reintroduction the gharials is worrying. According to Maskey and Percival (1994) only 19 gharials survived from 273 individuals released between 1980 and 1993 in the Narayani River. The recruitment of adult gharials from the pool of released juveniles is very low (Madhu, 1977; Maskey, 1989); during the first years after release, annual survival of reintroduced specimens is estimated to 50 % only. Overall, the reintroduction program maintains the population but it remains very fragile.

Threats

Despite legal protection, a number of threats compromise the survival of the gharial in Chitwan National Park (Maskey *et al.,* 2006). In the past, poaching of gharials and eggs for medicine, believed mystical values and food was considered the main threat. By the late 1970s the drastic depletion in their abundance and distribution was attributed to the lack of strict habitat protection. This study suggests that additional factors are likely to be important. Field observations enabled to identify the main categories of threats:

1) The presence of the Nepal/India dam. The dam, not fitted with a fish ladder, causes food depletion (Madhu, 1977). Also, the release of monsoon overflow waters washes gharials out of protected areas (Bustard and Singh, 1983). However, considering the relatively high number of young gharials finding refuge in slow river (Rapti River) but that subsequently disappeared, other threats should be examined.

2) Human activity, grazing and fishing (Ballouard *et al.,* 2004; Cadi *et al.,* 2005). Sand mining is directly implicated in the loss of basking sites and grazing of stock near river banks also results in the habitat destruction of limited suitable habitat (Whitaker *et al.,* 2007; Hussain, 1999). Fishing activity results in: a) reduction of fish on which gharial feed; b) perturbed basking activity, and c) mortality caused by drift nets. Drift nets are prohibited but gharials with pieces of fishing net wrapped and tangled around their snouts are regularly observed. Small (young) gharials are the most vulnerable (Hussain, 1999), which could explain the low survival of released gharials.

3) Water pollution. Despite the lack of precise data, evidence suggests that water pollution plays a role. Industrial activity upstream on the Narayani River, notably beer and paper factories, produces waste chemicals and dirty water that are released into the river system. Over 10 years we observed a spectacular distribution shift of the adult gharial population from the Narayani to the Rapti River. Moreover, in strong contrast to 15 years ago, in the upper Narayani downstream of Narayangath (West and East Channel), nests have become extremely rare with only one found per year in Lamichaur (Maskey, pers. com). However these both segments of the Narayani contain suitable habitats that do not suffer from strong human disturbance compared to the Rapti River. This distribution shift into slower waters away from the downstream flow of potential waste products may reflect a reaction to water pollution.

Proposal for conservation

With only 200 breeding adults scattered in a few small areas in India and Nepal, the gharial is today close to extinction (Whitaker *et al.,* 2007; GCA, 2008). Gharials in the past have responded well to protective management initiatives (Whitaker and Andrews, 2003). But most of the efforts involved ex-situ breeding and reintroduction into the population. The results of this study show that this strategy had limited success. Undoubtedly with respect to the current status and the fragility of the gharial, in-situ and ex-situ conservation efforts must be improved. Five main conservation measures are urgent.

1- The strict protection of basking sites (Hussain, 2009). Such places are situated near deeper shores where the river forms large bends against the current (Ciliberti, 2003). Females select such sites for nesting (Maskey, 1989; Rao, 1988), and the males are likely to use these sites to access females. Sites such as Koriyamohan and Litteguintha on the Narayani, or Dumaria on the Rapti should be strictly protected from human activity especially from sand mining and fishing.
2- Prohibition of fishing in the main settling zones, notably around reintroduction sites.
3- Analysis and control of industrial waste.
4- Fish ladders should be constructed and fitted to the dam under fishery biologists' supervision (Madhu, 1977).
5- Captive breeding. The maintenance of the stock of captive raised gharials is important for two main reasons. Firstly, because captivity offers an alternative to avoid the extinction of the species. Secondly, artificially incubated eggs collected in the field and those obtained from reproduction in captivity provide the individuals for the reintroduction program. Strong vigilance of the pool of captive gharials is needed in case of epizooty (Le Foll, 1982). Gharial should be fed only live fish for at least one month prior to their release to acclimate them to wild conditions (Maskey, 1989).

Re-introductions are essential to maintain wild population. Improving survival rate of re-introduced gharials is a priority. The following measures are proposed (Maskey, 1989; Cadi *et al.*, 2005):

1- Releasing gharials in sites with undisturbed habitat and where monsoon flood are the moderate (e.g. Rapti river).
2- Releasing gharial during the best periods for settlement before monsoon (February).
3- Releasing individuals in other protected area as the Bardia National Park (Babai and Karnali rivers) which offers good quality habitats with low disturbance (Smith *et al.,* 1996; Ballouard *et al*., 2007).
4- Releasing young gharials (2 to 5 years old).

5- Long term monitoring of released animals.

Conservation success will depend on the acceptance and participation of local people. Implementation of conservation initiatives must be achieved on a long-term basis through awareness, education and the involvement of local people with an interest in the area. Buffer zone community must be a key component as it involves people in resource management of the park throughout a participatory approach (Bajimaya, 2006). For example, fisherman could be employed as "gharial sentinels". The implementation of strict rules should be compensated by practical solutions, for example construction of fishing ponds. International cooperation is required, notably to help with the acquisition of biological knowledge, funding and education campaign (GCA, 2008).Cooperation between Nepal and India could allow a common steady and legal protection for gharials passing through the dam situated near the frontier. The implementation of conservation measures is important because: 1. In the absence of any action the recent trend suggests this species will become extinct, 2. As a "surrogate species" combining the concepts of sentinel, umbrella and flagship species, conservation of the gharial and preservation of its habitat could be vehicle for maintaining biodiversity of the whole freshwater ecosystem.

Acknowledgments

We would like to dedicate this study to late Dr T.M. Maskey (previous director of National Parks and Wildlife Conservation Department in Nepal) who initiated and conducted the Gharial Conservation Program in Nepal since 1981. I would like to particularly thank Xavier Bonnet for his comments and help on the manuscript. Luc Fougeirol from the Crocodile Farm of Pierrelatte (France) founded the program. We also thank Jim Edwards (Tiger Moutain lodges), Aimee Junker and the Tharu lodge staff (valuable help in the field and kindness). The team of the Gharial Conservation Project and the Tiger Tops naturalist team for all information shared. We would like to thank Rex Cambag, Pascal Villars for their comments on the manuscript. We thank the 2 anonymous reviewers for the improvement of the earlier manuscript and Virginie Delmas for her help to draw the map.

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Valorisation de la thèse

Congrès Internationaux

Ballouard J-M, X Bonnet et al. A large survey shows that emotion hence field experinces are essential to stimulate pupils to protect local biodiversity. 2nd Europeen Congress of Conservation Biology, Prague Czech Republic 01-05 Septembre 2009.

Ballouard J-M., Provost, G., Lassay, J. L. Bonnet, X. Field management and education, a successful story Plenary Session. 3rd Biology of the Vipers Conference Calci (Pisa, Italy) 31st March-2nd April 2010.

Joris A., Bonnet X., **Ballouard J-M.**, Michel C. Successful excision of the venom glands in four genus of viperid snakes: dangerous versus harmless snakes. 3rd Biology of the Vipers Conference Calci (Pisa, Italy)
31st March-2nd April 2010.

Congrès nationaux

Ballouard J-M, X Bonnet « Le Peuple Des Broussailles » : Projet d'éducation et de Conservation. Congrès de la Société Herpétologique de France, La Rochelle 2-4 Octobre 2008.

Provost, G., Lassay, J.L Bonnet X. et **Ballouard, J.M.** Un cas spectaculaire de restauration de l'habitat favorable aux serpents. Congrès de la Société Herpétologique de France, La Rochelle 2-4 Octobre 2008.

Ballouard J-M, X Bonnet et al. Sorties sur Le Terrain et Manipulations sont les clés de l'éducation a l'environnement : y compris avec les Reptiles ! 37ème Congrès de la Société Herpétologique de France, Montpellier 8-10 Octobre 2009

Ballouard J-M, Bonnet et al. Sorties sur Le Terrain et Manipulations sont les clés de l'éducation a l'environnement : y compris avec les Reptiles !5e Rencontres Nationales sur la Conservation des amphibiens et des reptiles 2010 30 Octobre, Ménigoute.

Posters

Levadoux JB, Bonnet XB, **Ballouard JM**, Lucas A. Snake population are on the negative slope: Evidence from long-term survey. 37ème Congrès de la Société Herpétologique de France, Montpellier 8-10 Octobre 2009.

Animation-Sensibilisation

Conférence

- Vendredi 27 février : Soirée thématique sur les serpents
  Présentation de la famille par Jean-Marie Ballouard (CNRS), de leur biologie et des actions d'éducation à l'environnement et d'aménagements conservatoires.
  RDV : Hôtel de la vie associative de Niort, 20h30

Articles de vulgarisations

- Revue naturaliste des Deux-Sèvres, "Nature entre Deux-Sèvres"
- Revue « Goupil », le magazine de l'Aspas

Animations

- Festival des associations écologiques Bourges 2007 et 2008, « Le peuples des broussailles » ***Premier prix en 2008***
- Fêtes de la science (2009-2010)
- Nichoir dans la pleine (2009-2010)
- APIEE
- Aérodrome de Niort

Enseignement et formation

- Encadrement de stages universitaires : Université D'Angers UCO; ***3 semaines***

- Encadrement de TD « projets personnels » (une semaine) : Université Poitiers M1 et M2, Université Tours M1 et M2, Université Angers UCO, université La Riche sur Yon ; ***12 semaines***

- Sortie de terrain (herpethologqiue, ornithologiques) : Université de la Rochelles, Tours, Poitiers, La Roche sur Yion ; ***20 sorties***

- Formation, ONF, ONEMA, ATEN: ***trois semaines***

- Encadrement stagiaires : BTS » GPN » (**11**) ; Master 1 (**2**), Licence 3 (**2**)

Charismatic species, local species, and snakes in environmental education

Evaluating children's perception to protect fauna in ten countries, and outdoor experience

Environmental education is one of the main tools to overcome the current loss of biodiversity. Future citizen, children are primary concerned. Media and school occupy a central place to educate public, but they broadcast almost exclusively messages based on few spectacular and exotic animals (polar bear, whales…). The main danger is that public and children may well have a narrow perception of the biodiversity and conservation issues, limited to few charismatic animals at the expense of the local biodiversity. Scholar education has a crucial role to promote knowledge, awareness, of schoolchildren and thus their willingness to protect a wide range of organisms, including less popular species. Using written questionnaires, we surveyed in ten different countries on Europe 7, Africa 1, and Asia 2, the perceptions of schoolchildren aged from 6 to 14 years for animals. The outcome is alarming: schoolchildren are disconnected from their local environment. Mirroring media, schoolchildren can list very few animal species requiring protection, some pets and charismatic mammals they watched on TV screens. However, a survey of the perception of schoolchildren for snakes showed a moderate aversion level and a clear willingness to protect them, a surprising and encouraging result. We brought almost 600 children to discover native snakes through a scientific and concrete approach including physical contact. We quantified the changes in the attitudes of the children. Via the activation of the affective channel, almost all the children expressed their willingness to protect snakes, at the same level than panda and other loveable species. This study reveals the failure of the scholar educational system that focuses on dogmatic message, virtual information and intellectual approach to the detriment of field trips and physical contact with wildlife. A concrete approach of biodiversity is however essential and urgent to reconnect children with their local environment. Our results reinforce the (so far) fruitless message that schoolchildren should be bring into the field to generate positive attitude and behaviour toward the protection of the biodiversity. Environmental education should not neglect organisms declared as unpopular by adults. To progress, significant efforts must be produced to not limit conservation messages and actions to few iconic species.

Key words: Biodiversity conservation, environmental education, local biodiversity, charismatic species, media, snake, field trip.