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Sustainable use of caiman in Argentina: An analysis from the perspective of the stakeholders involved

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ABSTRACT

Commercial use of wildlife is considered a potential tool of conservation and sustainable development, under the ideological assumption that the economic valuation of them generates incentives for conservation, as well as the ecosystems they inhabit, while benefiting local communities. However, many authors question the scope of these initiatives. The reptiles represent 61% of the value of this trade. Two species of Caiman genus inhabit Argentina. In 1997, a ranching farm was developed in Santa Fe province; between 1997 and 2004, more ranching farms were developed in other four Argentinean provinces. This paper aims to develop a conceptual model of the production system and its influence on sustainability trajectory in commercial use of caiman in Argentina based on the stakeholders` perception. The information obtained from interviews was organized into two results: 1) a conceptual model representing the caiman production system, and 2) a stakeholder network. This paper provided insights about the caiman production system and its articulation with the stakeholders involved. Throughout the qualitative analyses here implemented, we have obtained a diagnostic tool which could be converted into a planning tool incorporating quantitative information.

1. Introduction

Commercial use of wildlife is considered a potential tool of conservation and sustainable development, under the ideological assumption that the economic valuation of wildlife generates incentives for conservation, as well as the ecosystems they inhabit, while benefiting local communities (WCED, 1987; IUCN/UNEP/WWF, 1980; Robinson and Redford, 1991; CDB, 1992; Ojasti and Dallmeier, 2002; Larriera, 2011). Therefore productions based on wildlife are promoted as an alternative land use to traditional agriculture. However, many authors question the scope of these initiatives (Robinson, 1993; Ludwig et al., 1993; Costanza and Patten, 1995; Hansen, 1996; Larriera, 2011), because is not enough to assess the intensity of extraction, the effect of the removal of individuals on the biological community and ecosystem function, but it is also necessary to determine the needs, aspirations and rights of the different groups using the resources (e.g. local communities, entrepreneurs, institutions). A systematic approach is required to analyze these variables together (Checkland, 1981, Senge, 1990, Meadows and Wright, 2009, Ostrom, 2009) in order to account the complex relationships established in production systems. It is important to recognize the socio-economic drivers that may influence the trajectory of the production system (Rivas, 2007) and therefore its effectiveness in the conservation of species and those ecosystems where they inhabit.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) estimated that wild fauna products are legally sold for between 350 and 530 million dollars per year (CITES, 2012). The reptiles (live and skins) are the most significant taxonomic group between the five that are sold, representing 61% of the value of this trade. In the international leather market, three of the five species that are being the most traded are crocodilian. This market has recorded 13 species from more than 35 countries. They are divided into two groups, in relation to size and leather quality: 1) *Caiman* genus and 2) *Crocodylus* and *Alligator* genus.

Two species of *Caiman* genus inhabit in Argentina: the broad-snouted caiman *(Caiman latirostris)* and the yacare caiman *(Caiman*

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yacare), belonging to Alligatoridae family of Crocodylia order (Ross, 1995). They are sympatric in Chaco, Corrientes, Formosa and Santa Fe. *Caiman latirostris* also inhabits in Entre Ríos, Misiones, Salta and Jujuy (Waller and Micucci, 1993; Larriera and Imhof, 2006). In other South American countries, broad-snouted caiman could be found in marshy and lacustrine regions of Bolivia, Brasil, Paraguay and Uruguay, and yacare caiman could be found in the southwestern of Brasil, eastern of Bolivia and Paraguay. Under the "National Program Management and Sustainable Use of Wildlife", coordinated by the Department of Wildlife - Ministry of Environment and Sustainable Development, 5 ranching farms were developed. The ranching technique consists of harvesting wild eggs for captive rearing (for more details, see Larriera, 1990, 1991, 2011). Through the Argentine experience in the commercial use of caiman, this paper aims to develop a conceptual model of this production system and its influence on sustainability trajectory based on stakeholders` perceptions in order to develop a diagnostic tool that tends to visualize the magnitude of the intervention in nature, according to the social interests that underlie, and assess the impact of the intervention on the conservation of the species used.

This paper is a qualitative assessment and, as a consequence, it is considered interpretative, inductive, multimethodic and reflexive. The methodology used is flexible and sensitive to the social context where data were obtained. This work tries to provide new perspectives about what is known, described and explained (Vasilachis de Gialdino, 2006) on the sustainable use of wildlife species.

2. Materials and methods

2.1. Determination of the assessment unit and its sample

Social actors involved in the development of Argentinean ranching farms for caiman production are the assessment unit.

The assessment unit was sampled based on stakeholders´ type, in relation to their role within the production system. Number and type of social actors were increased with the snowball sampling technique (Guber, 2001), asking first informants to identify other people with knowledge about the system analyzed. This technique allowed the access to those social actors that could not be easily identified (e.g. nests identifiers, egg collectors). Two factors were considered in order to obtain an adequate sample: 1) time, relative to the variation of productive activities throughout the year; and 2) place and context, the meeting with each social actor was performed in places where they work. Sampling was completed by data saturation; i.e. this happens when no new information is obtained from the addition of more informants or becomes redundant (Taylor and Bogdan, 1987).

The final sample consisted on nineteen stakeholders: 1) owners and/or managers of ranching farms (6 respondents), 2) representatives of government institutions (2 respondents), 3) nests identifiers and egg collectors (6 respondents), 4) technical consultants (2 respondents), and 5) researchers (3 respondents). Considering that these stakeholders prefer confidentiality, their names could not be displayed.

2.2. Field work and data collection

With the aim of preparing the field work, a historical review of caiman use in Argentina and the development of conservation strategies was made. Scientific publications and outreach material were used (Guber, 2001). Between 2009 and 2012, four trips were made to visit five ranching farms present in Argentina. These ranching farms were located in Formosa, Chaco, Corrientes, Santa Fe and Entre Rios provinces (Fig. 1).

During field work, data were collected using two ethnographic techniques: 1) semi-structured interviews, and 2) participant observation. A semi-structured interview consists of open questions listed a priori defining a thematic guide. This is based on the research objective and the particularities of stakeholders that make up the production system. During the interview, these questions were reformulated or extended from the information provided by the interviewee (Guber, 1994; Taylor and Bogdan, 1987). Data were collected using recorder when the interviewee allowed it or alternatively in a fieldbook. Nineteen interviews were conducted; i.e. an interview per stakeholder.

Regarding the use of participant observation technique, two simultaneous activities were carried out: a) everything that happened in the environment was systematically observed, and b) one of the authors participated in productive activities with the interviewees (Taylor and Bogdan, 1987; Guber, 2001). Records arising from this technique were used to amplify, supplement and/or validate the information collected through semi-structured interviews.

2.3. Data analysis and techniques used

Information obtained from interviews was transcripted in order to be codified with Atlas Ti software (Chernobilsky, 2006). The encoding consists on putting conceptual names or categories to different observations, texts or interviews in order to make an abstraction. This abstraction is a conceptual categorization with its own properties and variations. The information revealed from interviews and participant observation was coded. The encoding considers whether information obtained is a) supplemented, b) affirmed or c) opposed within stakeholders interviewed. After encoding, the information was organized into two main results: 1) a conceptual model for the caiman production system, and 2) a stakeholder network. This second result consists on a social network; i.e. a graphical representation of the relationships established among social actors.

Finally, the relationships established by different stakeholders involved in the caiman production system were analyzed. In order to do this, the UCINET software was used (Borgatti et al., 2002), which allows setting the link of relationships established among different actors within a network. The temporal periods of the network structure were obtained from the interviews. The network structure was analyzed based on two indicators:

1) Density: this indicator presents the number of observed relationships out of the total number of possible relationships, allowing determining the extent to which it is connected the general conceptual network. Density is calculated as follows:

$$D = \frac{1}{n(n-1)} \sum_{i=1}^{n} \sum_{j=1}^{n} a_{ij} \quad (1)$$

where a_{ij} is the relational component between the node i and the node j, and n is the number of nodes within the network.

2) Centralization: the degree of centralization of a network indicates how close the network behaves as a star network, in which a stakeholder plays a central role in controlling the entire network; or how far is from that behavior, which is more favorable because it speaks of a well-connected network. The centralization index (CD) of a graph (G) is calculated as follows:

$$C_D(G) = \frac{\sum_{i=1}^{|V|} [C_D(v^*) - C_D(v_i)]}{H} \quad (2)$$

where v_i is a particular node; v^* is the node with the highest degree centrality in G; $|V|$ are the vertices of the graph; H is maximized when the graph contains one central node to which all other nodes are connected.

2.4. Study restrictions

Qualitative researchers observe, interact with, transform and are transformed by their informants (in our case study, stakeholders). Their activity is based on relationships and the phenomenon under study could modify their point of view. Even though the methodology is

Fig. 1. Argentine map indicating Formosa (1), Chaco (2), Corrientes (3), Santa Fe (4) and Entre Rios (5) provinces where the ranching farms are located.

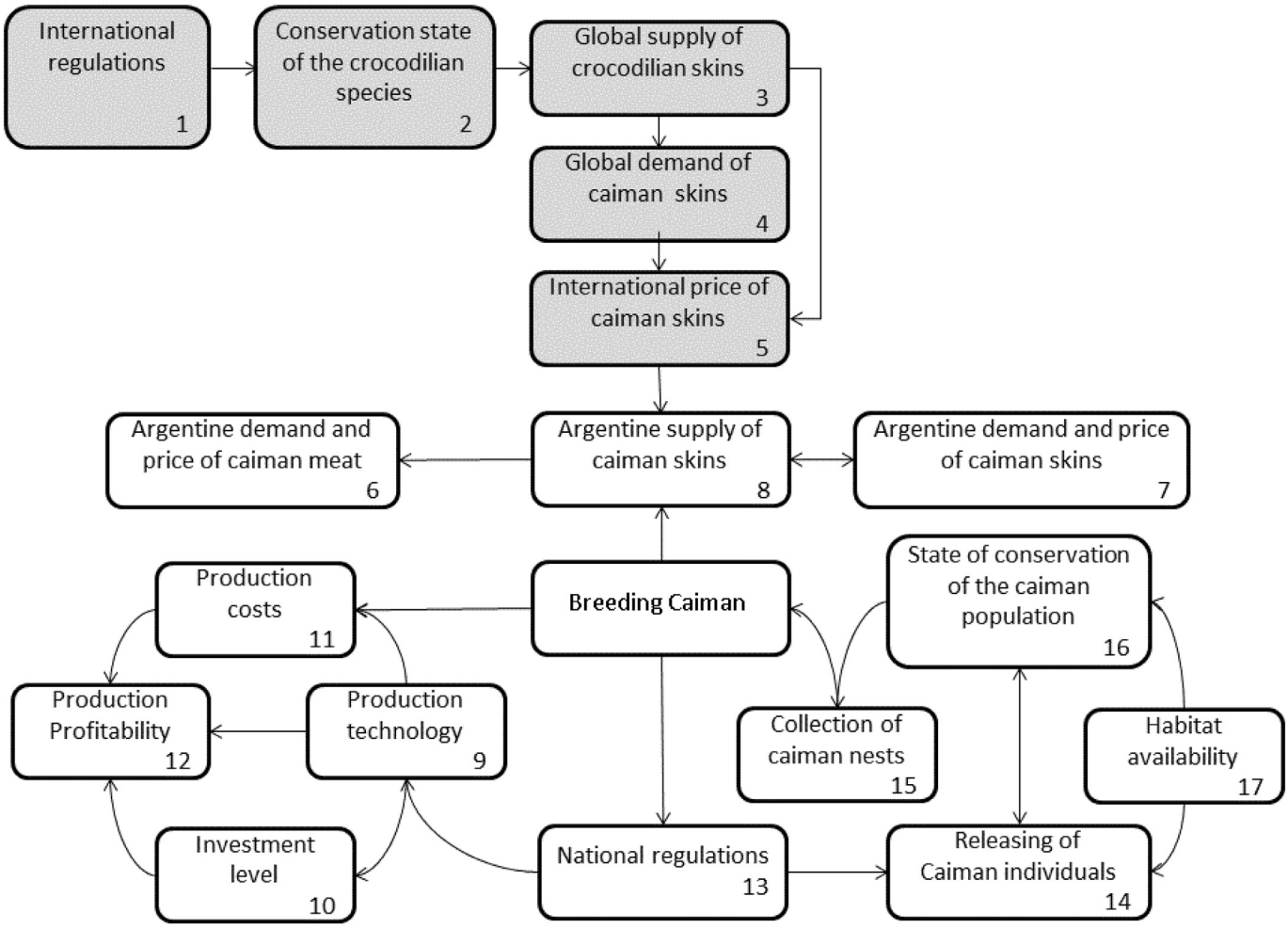


Fig. 2. Conceptual model of caiman production system in Argentina. International variables are gray shaded and local variables are not shaded. Numbers represent each variable in order to facilitate the explanation of the conceptual model. If the conceptual model is used as a diagnostic and/or planning tool, caiman species should be specified when assessing and/or quantifying variables (15) and (16).

explained in detail, it is possible that results obtained would not be the same in other context (Vasilachis de Gialdino, 2006).

3. Results

3.1. Conceptual model of caiman production system in Argentina

Fig. 2 represents the main variables and relationships among them obtained from the encoding process based on semi-structured interviews and participant observation. These variables have a number in order to easily explained them. In the following text, it is presented the data collected linked to each variable (with a number in parenthesis) (Fig. 2).

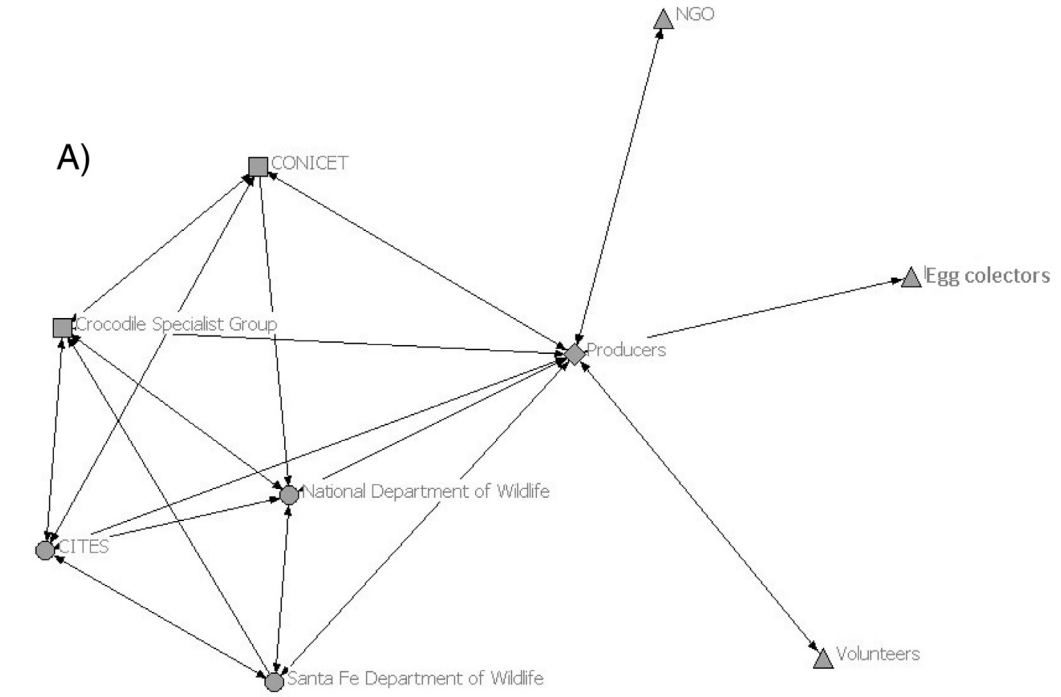
Global demand of caiman skins (4), in volume and value, was influenced by global supply of crocodilian skins (3), which depends on conservation state of crocodilian species (2) and international regulations (1). Argentina supplied global demand of caiman skins (4) because trade controls of skins from Crocodylus and Alligator genus increased (3), in association with the low price of caiman skins (5) and the difficulty of South American countries to efficiently control exports and imports, resulting in an illegal market. It is estimated that during the 1940s a minimum of 10,000 skins/year was exported, reaching 25,000 skins/year in the 1970s (Micucci and Waller, 1995; Thorbjarnarson, 1999).

At the end of the 1940s, the overexploitation of caiman populations became increasingly evident and control regulations were consequently developed at national and provincial levels (13) (Micucci and Waller, 1995). Since 1981, Argentina ratified the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1). In the early 1990s, illegal trade began to decline in relation to the decrease in the product price (5) and the prohibition of importing skins of species similar to native ones (13).

Variables (1), (2), (3), (4) and (5) were considered at global scale and determined the production profitability (12) of ranching farms at local scale.

Production profitability (12) of ranching farms was influenced by two economic variables: 1) investment level (10), and 2) production costs (11). These variables were determined by production technology (9), and defined according to national (13) and international regulations (1). Ranching technique (9) is considered a key aspect because it favors habitat conservation (17), diminishes production costs in relation to breeding farms (11), and includes local residents into the production system (15). However, a producer considered the limits of this technology: "*…high initial capital investment in infrastructure is required with a return that would occur between 3 and 5 years…*" (10), also "*…some years is not possible to release caiman individuals because of weather conditions…then, we must feed animals that are not going to be sold; so, the costs increase…*"(11).

Caiman skins are the main product of Argentinean ranching farms. During 2001–2010, Argentina exported 38,384 skin units (CITES,


A)
NGO
CONICET
Egg colectors
Crocodile Specialist Group
Producers
National Department of Wildlife
CITES
Volunteers
Santa Fe Department of Wildlife

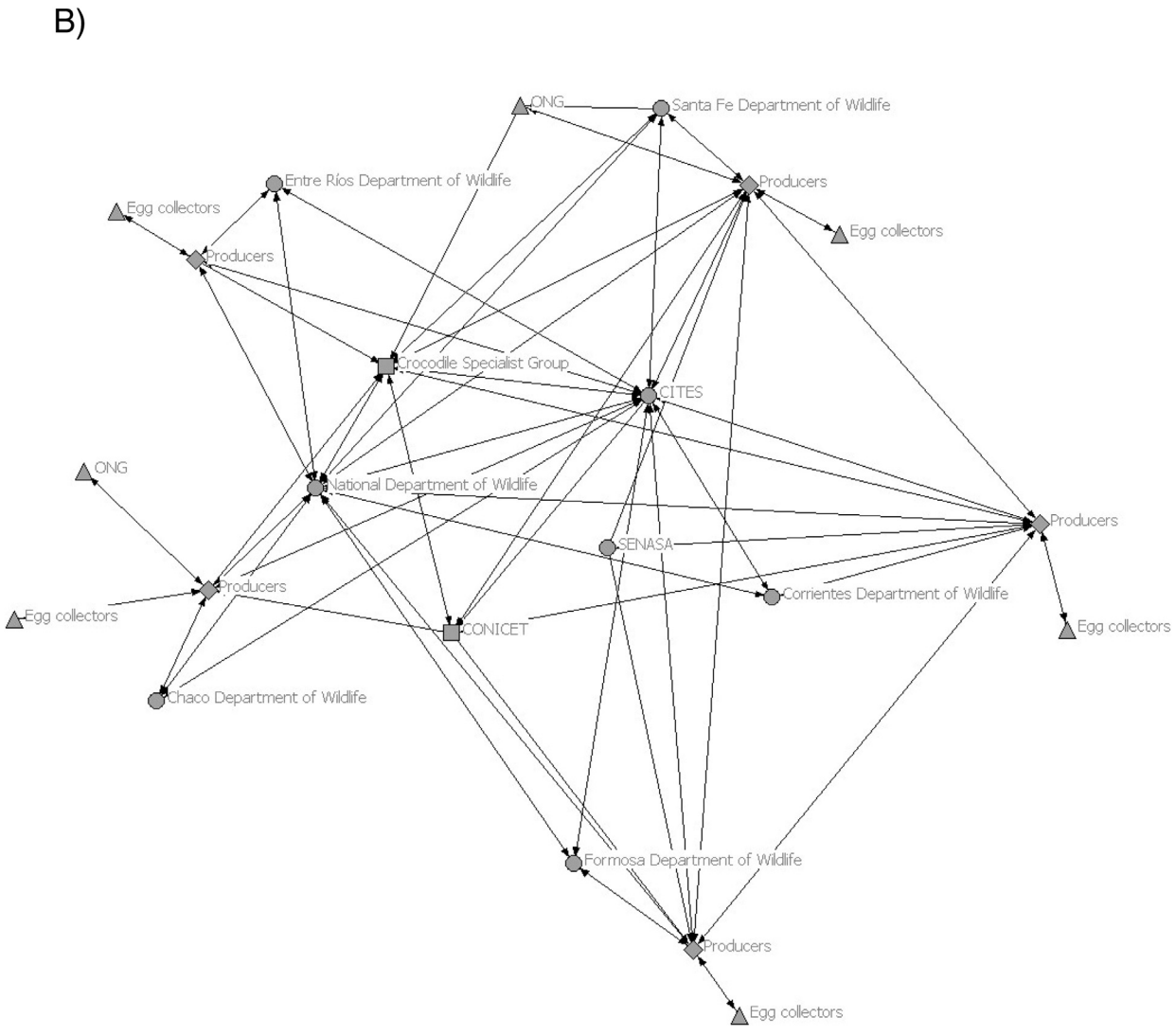

B)
ONG
Santa Fe Department of Wildlife
Entre Ríos Department of Wildlife
Producers
Egg collectors
Egg collectors
Producers
Crocodile Specialist Group
CITES
ONG
National Department of Wildlife
Producers
SENASA
Producers
Corrientes Department of Wildlife
Egg collectors
CONICET
Egg collectors
Chaco Department of Wildlife
Formosa Department of Wildlife
Producers
Egg collectors

Fig. 3. Stakeholder network of caiman production system in Argentina during three periods: 1) Start of *Caiman latirostris* Experimental Ranching Program - Change of *Caiman latirostris* to CITES-Appendix II (1990–1997) (A); 2) Development of ranching farms (1998–2007) (B); and, 3) Inactivity of a ranching farm (2008–2012) (C). References: Circle: Regulatory institution agents; Square: Researchers; Triangle: Local residents; Diamant: Producers. NGO: Non Governmental Organizations; CONICET: National Council for Scientific Research; SENASA: National Service of Food Safety; CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora.

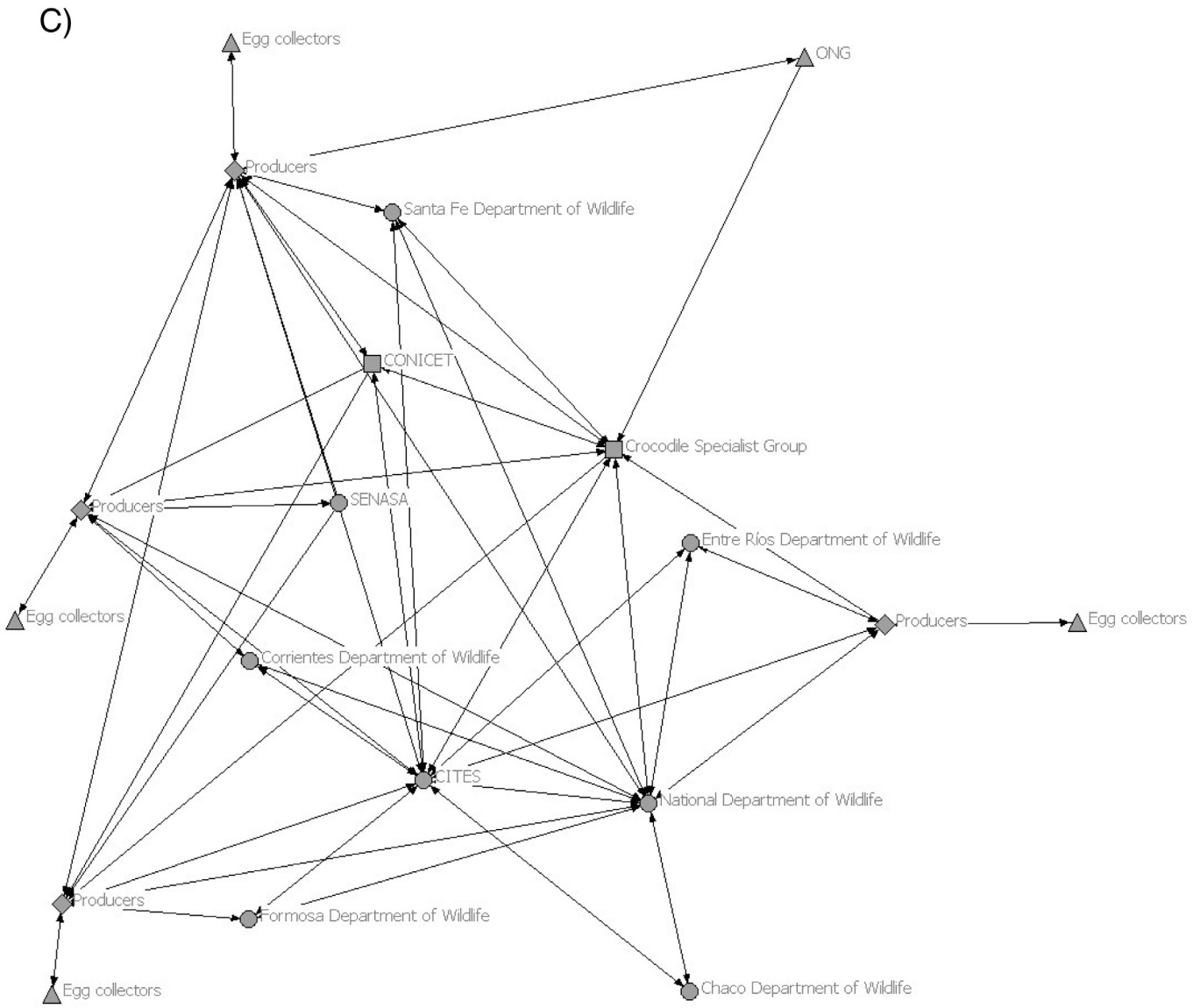


Fig. 3. (*continued*)

2011). The principal imported countries were USA, Germany, Japan, Mexico and Italy (Caldwell, 2013) (8). Caiman meat is a secondary product for domestic market (6). It is mainly distributed in restaurants. Export transactions of caiman meat were only recorded in 2006 and 2007, with a total of 1250 kg and 3109 kg, respectively. However, meat export did not continue because Bolivia and other countries from Africa and Asia were very competitive. Domestic market for caiman skins (7) has not been significant. Producers and government agents have also recognized the importance of developing value-added products, but have indicated that a large capital investment regarding design and manufacture is required. However, these products are not of interest to importing countries.

Table 1
Density and centralization indicators (in percentage) for each stakeholder network of the caiman production system in Argentina during three periods: 1) Start of *Caiman latirostris* Experimental Ranching Program - Change of *Caiman latirostris* to CITES-Appendix II (1990–1997); 2) Development of ranching farms (1998–2007); and, 3) Inactivity of a ranching farm (2008–2012).

Time period	Density	Centralization
1990–1997	44.44%	67.86%
1998–2007	21.43%	42.38%
2008–2012	18.61%	40.48%

Variables (6) and (7) had less weight on production profitability (12) of ranching farms because volume sales were lower compared to international market. Producers and government agents highlighted the dependence on international market and fluctuations in demand, related to the economic crisis of importing countries or changes in fashion preferences. This aspect impacts on production profitability (12) and, as a consequence, on business continuity. According to interviewees, global demand of caiman skins (4) is the most influential element in the continuity of production units.

Some producers and government agents have identified the

promotion of production technology (9), used as a marketing strategy (12). However, they have clarified that it is required a great effort in communication and environmental education because *"there are social groups that discourage the use of wildlife and do not identify its potential for species conservation*". Another interviewee added to this idea by stating that *"… part of the profits must be reinvested in new research and environmental education activities in areas where the project is implemented…"*

Habitat availability (17) both influenced collection of caiman nests (15) and the percentage of caiman individuals which would be released (14) by ranching farms for the repopulation process. Caiman nest collection (15) includes nests identification and eggs collection. One producer emphasized that this activity *"is based on relationships of trust among us [the producers] and egg collectors",* and he recalled the initial distrust of productive projects. An egg collector had a similar opinion recognizing that only some local residents were initially involved. When egg collectors started to widespread the economic benefits of this activity, other local residents started to participate. However, this egg collector also said that *"Here, many local residents could participate, but they do not do it because they are afraid, they do not like the work, they do not know the species or they do not like to walk where the nests are"*, and added that *"time, care and patience are required, you have to like it"*. Egg collectors have also recognized that this task could be complemented with other productive activities (e.g. cattle); this facilitates involvement continuity through years. Despite economic benefits of egg collection, this activity continues to be an informal practice.

Producers, government agents and researchers believe that local residents´ perception about natural resource has changed. For example, egg collectors working on livestock farms were more effective in controlling illegal hunting than before ranching farms creation (16). Others believe that marginal stakeholders (e.g. hunters) were included into the production system. An interviewee [researcher] said that "*through collecting eggs, people pass from an illegal activity [hunting] to a legal one [ranching]*" (16).

3.2. Stakeholder networks

Caiman production system is developed based on relationships among the stakeholders involved; that is, researchers, regulatory institution agents, farm managers or farm owners, and local residents. From the information provided by interviewees, three time periods were identified in the development of the system: 1) Start of *Caiman latirostris* Experimental Ranching Program - Change of *Caiman latirostris* to CITES-Appendix II (1990–1997) (Fig. 3a); 2) Development of ranching farms (1998–2007) (Fig. 3b); and 3) Inactivity of a ranching farm (2008–2012) (Fig. 3c). In each time period, the following types of nodes were identified: producers, researchers, regulatory institutions, egg collectors and non-governmental organizations (NGO).

The quantity of producers has increased since 1997, in association with the change of *Caiman latirostris* to CITES-Appendix II. The inclusion of new producers to the network leads to an increase of local residents involved in identifying nests and collecting eggs.

The increase in the number of stakeholders modified the structural indicators (Table 1). Density decreased in the last period (2008–2012) (18.61%) compared to the first period (1990–1997) (44.44%) (Table 1). Network centralization had a similar tendency regarding density (Table 1). This indicator decreased from 67.86% in 1990–1997 to 40.48% in 2008–2012.

4. Discussion

This paper characterized caiman production system in Argentina from the stakeholder's point of view. As far as we are aware, this is the first study that visualizes the perception of a group of stakeholders directly related to the production system of a wildlife species. This paper showed differences with previous studies that have analyzed caiman production based on: 1) production-technological system (Jenkins, 1987, Larrierra and Imhof 2006), 2) global market for crocodile skins (Mc Gregor, 2006), and 3) agribusiness chain (Vieites et al., 2007). The methodological approach of this work has been previously used to evaluate the snail (*Helix aspersa*) production system (Gelabert et al., 2013).

The conceptual model of caiman production system in Argentina not only allowed the conceptualization of the system considering their productive and commercial phases (Fig. 2), but also the recognition of two key variables in the system: 1) global demand of crocodile skins, and 2) technology used. The first variable (i.e. global demand of crocodile skins) defines the interaction between spatial scales; i.e. linking local production (and the territory in which it is developed) with international market. The involvement of local stakeholders in the international skins demand is null or minimal. This is possible only through instances of discussion of the international regulatory framework. The second variable (i.e. technology used) modifies local practices and sets a link with the territory. At the same time, this variable defines three aspects: 1) which are the potential producers to carry out production in association with investment levels required; 2) social relationships established around the production system; and 3) the change of wildlife resource ownership added to the appropriation of economic benefits. Thus, wildlife resource (i.e. common good) is converted from public to private domain (Rabinovich et al., 2001). Changes in the allocation of property rights generate income for the stakeholders involved (Rabinovich et al., 2001), so business decisions regarding resource use might influence community benefits, determining the collective choice about using a common good (Runge, 1992; Oakerson, 1992).

Stakeholder networks, and their evolution, make it possible to recognize that their links are chained (Fig. 3). For example, regulatory institutions are linked with producers, and these latter with egg collectors. Even though the number of stakeholders has increased, the number of relations among them had a low variation among time periods (Fig. 3). From the connectivist perspective (less common in wildlife analysis), it would have been desirable not a chain linkage, but multiple relations among social actors (Borgatti and Foster, 2003). This social perspective not only considers nodes and their positions but also relationships among them. Nodes (i.e.social actors) are considered as potential regulators of resources mobilized within the network, while linkages are considered as drivers of different resources (e.g. information, money). Moreover, networks obtained showed two key links: 1) informal links between producers and local residents (i.e. egg collectors), and 2) formal links between government agencies and ranching farms (Fig. 3). Links were also observed among researchers, mainly those that make up the Crocodile Specialist Group of the International Union for Conservation of Nature (IUCN).

Density and centralization indices could be associated with stakeholders´ attributes (Schneider et al., 2003; Olsson et al., 2004; Bodin et al., 2006) (Table 1). In the case of density, low values may be associated with less redundancy and greater heterogeneity in the information that circulates in the networks (Schneider et al., 2003; Olsson et al., 2004; Bodin et al., 2006). Based on the information obtained in the interviews, this not occurs here. For example, practices that stakeholders perform are similar among node types because they use the same production technology and three ranching farms share the same technical advisor and institutional rules. From the beginning of the activity to the present, nodes redundancy generated a competitive advantage by optimizing resources in the process of knowledge generation and its technological implementation - adoption. However, a particular ranching farm plays a key role in knowledge generation and technological development. From an adaptive management perspective, it could pose a potential risk in the event that the farm ceases its activity (Meffe et al., 2002). In this sense, network variations could be associated with marketing strategies and territorial areas where ranching farms are located. Consequently, the loss of "producer" nodes decreases the territorial scope of the system. Regarding centralization, its decline

could be associated with a lower capacity for coordination and management (Walker et al., 2004). Regulatory institutions and the first productive enterprise could act as coordinators of the system at critical period times (Newman and Dale, 2005).

Results obtained through social networks analysis (i.e. quantitative data) and semi-structure interviews (i.e. qualitative data) highlight the importance of double reading. The description of the social structure established by social actors (and their links) would be insufficient if social actors' perceptions would not be considered, because they can regulate those resources that circulate in the network from different interests at stake. Then, it is important to identify which social practices are developed in the system, specific capitals (e.g. economic, social) and interests for determining the social actors´ positions, recognizing its current position but also the trajectory of that position (Bourdieu, 1988).

Stakeholders' perceptions brought new questions about the incentives generated by the system for species conservation and its habitat. Although stakeholders have recognized the positive impact on ecosystems conservation, they believe that their contribution is limited. Local residents are limited in their ability to join in the production system. This alternative production system is not very competitive in comparison with traditional land uses because it has a specific market and investment levels are high (Zylbersztajn, 1995; Cetrángolo, 2005).

5. Conclusion

This paper provided insights about the caiman production system and its articulation with the stakeholders involved. We highlighted social interests and its relationship with nature. In this way, we characterized this system recognizing the co-evolution between humans and nature. Throughout the qualitative analyses here implemented, we have obtained a diagnostic tool which could be converted into a planning tool incorporating quantitative information.

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