0624110 Participative Research on Biodiversity in (R.O.B.IN) Uruguayan artisanal red shrimp fishery

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and Punta del Diablo

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Escuela y Liceo N° 61 de Barra de Valizas (Local school and high school)

Our aim was to develop sustainable fishing gears while involving local people in marine biodiversity monitoring plans

We visit project site for fishing gear evaluation in January, May, June, August, September, October*, November* and December* in 2010 and January, February, March and April 2011
For educational activities, we travel to project site in July*, August*, September*, October*, November* and December in 2010.

* denotes two visit in the same month

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Acknowledgemes

We are deeply in debt to local fishermen, whose knowledge and friendship improved our way of thinking about natural systems and nature conservancy. We specially thank, Dardo, Rober, Manuel, Mabel, Alfredo, Claudio (Bala) and their crews. We acknowledged Annete, the head teacher of Valizas, whose open mind, creativity and energy improved the work realized in the school of Valizas.
Our friends and colleagues Alvar, Mariana (negra), Fabrizio, Alvaro, and Gustavo, for promoting interesting discussions about conservation in the theoretical and applied side. We are grateful to the Department of fishing technologies of DINARA, specially Yamandu, Julio, Bernardo and Gastón whose assistance in technical issues was instrumental to succeed in the project.
This project would have not been possible without the housing facilities of Punta Diablo and Valizas. Fabrino Scarabizio is specially thanked for assistance in invertebrate and fish identification and organization of MNHN collections. Gustavo Leucuona has to be mentioned specially as the great magician that gave life to the scale models of marine organisms. We are very grateful to his uninterested dedication, and professional work. Finally, we would like to thank all the people, whose diverse input made this project a little bit better.

Summary

Marine biodiversity is threatened by bottom trawl fisheries and it is largely unknown to general audience due to logistic difficulties in the observation of marine biota. With this project we evaluated in a participative way by scientists and artisanal fishermen the efficiency of a fish excluder device (DEPEJU) constructed and implemented in the artisanal shrimp fishery of Barra de Valizas, Uruguay. DEPEJU showed a great performance in the escape of bony fishes (~60%) and endangered elasmobranchs (>90%). However, almost 30% of marketable shrimps escapes, which impedes its commercial use by fishermen in actual form. In the project course, we gathered previously unknown information on biological aspects of several fish species; some of them endangered (*i.e.*, *Sympterygia acuta*) and raised local concern about marine biodiversity. We conducted environmental educational activities with local people and in the school. The culmination of educational activities was a puppet show concerning marine biodiversity and artisanal fisheries. It was devised and played by children from Barra de Valizas school, and in the preparation, children engaged local people, artists and scientists. We also mounted a scale model of the coastal marine zone in three local schools and community centres. Altogether, this project creates the basis for managing this coastal system by integrating scientific knowledge and local participation. More on, this project engaged a group of highly motivated young scientist in marine-conservation actions.

Introduction

Located in the South Atlantic Ocean, the Uruguayan shelf is characterized by a complex oceanographic system composed of water masses of contrasting thermohaline characteristics (Piola et al., 2000). This confluence zone defines biogeographic boundaries for much of the species in the zone, which present it southern or northernmost distributional limits. Thus, it presents high biodiversity values recognized at international (e.g. Biosphere reserve, UNESCO-MAB) and national scales (National System of protected areas; SNAP). Despite of the fact that the first three Uruguayan marine protected areas (MPA) are located in this zone (Figure 1), knowledge about its marine diversity is scarce. This situation gets more concern if we consider that there are artisanal shrimp fisheries operating in those areas. They capture shrimps using a bottom trawl net, which is not selective and capture unintentionally a large list of invertebrate and fish species which are generally discarded dead or injured (Segura et al., 2008ab). In this vein, this project addresses these problems by combining empirical and scientific knowledge to understand patterns in marine-coastal biodiversity and evaluate a modified artisanal bottom trawl net (DEPEJU). In order to do so, we worked together with artisanal fishermen, local educative centres and investigation and management agencies, such

as the Natural History Museum and the National and the Fisheries Resource Management Agency. Local people were involved in the project in two ways, 1) fishermen were included in the design and evaluation of the DEPEJU and 2) children participated in the educational program, which were based on an ecosystem-based approach and visits to the fishermen and related activities. The headmaster of the local school was active in facilitating meetings with teachers, improving educational contents and coordinating working plans. The national fisheries agency was instrumental in order to define and design the selective device. They meet artisanal fishermen in order to discuss technical aspects of the device and its implementation. A technician of the MNHN was crucial for the design and creation of the model scale of the marine ecosystem.

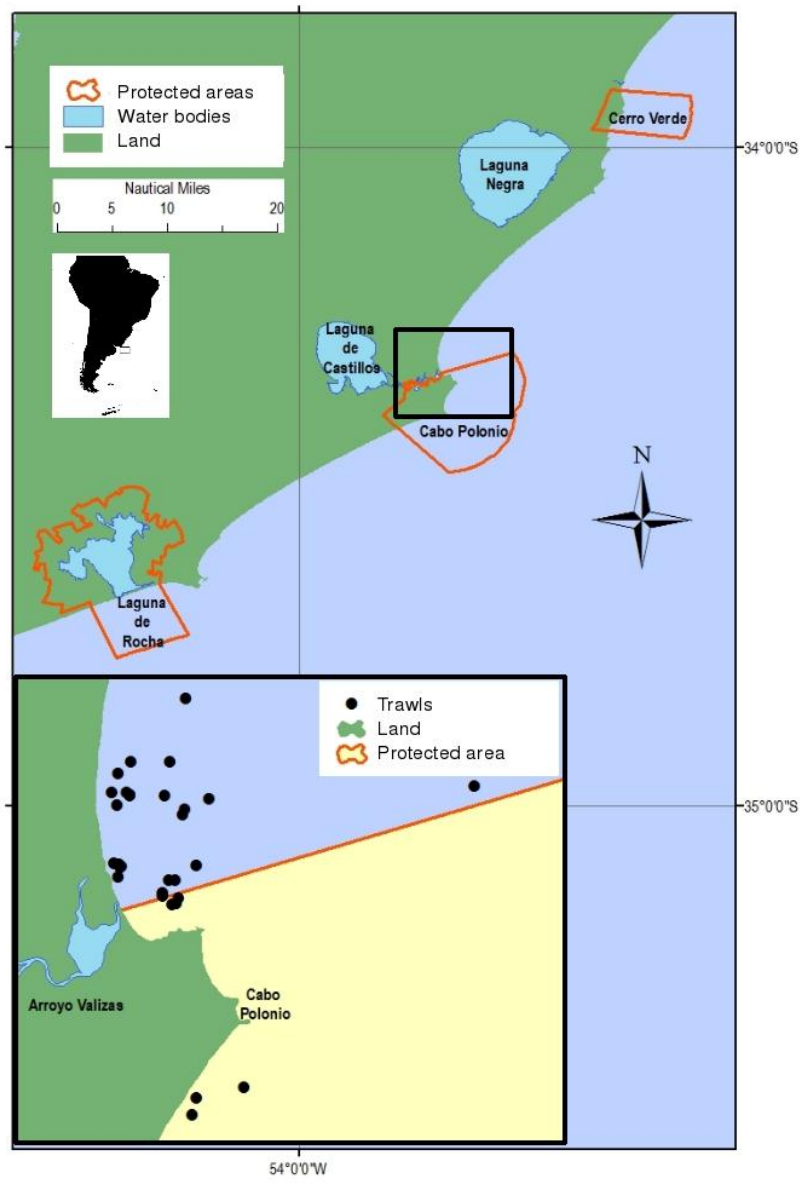

Figure 1. - Barra de Valizas study zone, Uruguay South America. Trawls evaluating the selective device (DEPEJU) were performed in the recently created Marine protected area of Cabo Polonio.

Project members

Angel Segura (aged 30), is interested in community assemblage and species coexistence. He finished his master thesis and it is involved in a PhD program addressing the mentioned topics. He is interested in marine conservation, focused on the interaction between social and biological systems. He has been leading coastal- marine biodiversity exploration projects in the zone for 5 years. He is now working as associated scientist in the Natural History Museum in the area of biodiversity and conservation.

Eliana Arismendi is a student on the Faulty of Science. She is interested in participative investigations and the perception of local stakeholder, including artisanal fishermen and managers concerning the creation of a new Marine Protected Area in the area of Punta del Diablo-Cerro Verde. She has special interest in educational outreach activities and designed and executed the plan implemented in this project. She is a collaborator of the Natural History Museum in the area of biodiversity and conservation.

Romina Trinchin is a student 23 years old who is in the last step to get her degree as bachelor in biological sciences. She is interested in marine biodiversity, population dynamics and conservation. She has been involved in the organization and execution of the field trips and on-board work. She is nowadays a collaborator of the Natural History Museum in the area of biodiversity and conservation as well as to the ichthyology and invertebrates zoology sections.

Javier Rabellino is a young scientist recently graduated in Biological Sciences at the Faculty of Science, Uruguay. He is interested in fish assemblage, communities and populations. He has experience on the field work (i.e. recognition of species, data processing). He helped in the preparation of biological samples for the collection of the Natural History Museum. He also contributed in the field work and is actually improving their skills on SIG techniques and software.

Aim and objectives

This project aimed to involve local communities, especially artisanal fishermen in registering, monitoring and protecting coastal-marine biodiversity. Our specific objectives were 1) Evaluate the performance of the DEPEJU on endangered species and 2) to reduce by catch by testing and implementing a recently developed BRD. 3) Generate a complete inventory of the biodiversity of macro invertebrates and fishes of the Cabo Polonio Marine Protected Area and 4) record seasonal changes in abundance of fish and invertebrates. 5) Educational and outreach objectives, were to raise local interest in biodiversity conservation through a series of educational and outreach activities. 6) As a management objective was to contribute to improve the Marine Protected Area management Plan and transfer gained knowledge to local community and government decision-makers.

Methodology

We contacted local fishermen individually to explain the idea of the project and the development of the DEPEJU. We also contacted relevant local stakeholders to inform the idea of the project and to invite them to join it. In several informal meetings, the functioning and the convenience of the use of the DEPEJU were discussed with fishermen. These informal talks were crucial to improve the DEPEJU and interchange empirical and traditional knowledge with fishermen.

In order to evaluate the performance of the net in terms of capture, we did trawls using fishermen standard net and the net with the DEPEJU included (Figure 2). The DEPEJU is a selection grid made from lightweight and common materials (pipes, garden-mesh), designed and implemented with fishermen in a participative fashion. The trawls duration was chosen as to give an adequate representation of the fish and invertebrate community as determined using previous rarefaction curves. We completed a total of four to ten trawls in each sampling visit, depending on weather conditions. When DEPEJU was installed, we placed on the escaping window a net to retain the fraction of fishes and shrimps that would have been escaped otherwise. We then calculated an excluding index as:

$$IE = CE / (CE+CR)$$

where CE is the excluded biomass in kg, and CR is the biomass retained in the cod end of the net. High IE is desired for fishes and invertebrates and low IE is expected for shrimps. Then, we compared averaged retained biomass to that which escaped by the DEPEJU by using paired t-test for a) red-shrimp, b) bony fishes, c) sharks and d) rays biomass. Collected organisms where measured in total length and weighted to the nearest mm and then fixed in alcohol. We choose preservation in alcoholic medium to allow samples to be available for future genetic studies. Organisms were transported to MNHN where they were prepared to be included in the ichthyology and invertebrate collections.

Educational outreach activities were based on stimulating children curiosity for nature by means of games and integral activities. At the beginning of the year, we had a meeting with head teacher and teachers at the school and high school in order to discuss and planificate the activities to develop in the following year. Then, we performed bimonthly activities for all the children and youth in the school, from kindergarten (age 4-5) to high school (age 14-15). The educational activities were set according to the age of children in different groups. The full program of activities is included as supporting material 1.

In order to raise concern on biodiversity issues, we collaborated with local people in the development and execution of a puppet show, and the installation of a model scale of the marine ecosystem. This was possible with the collaboration of technicians from the MNHN and local artists.

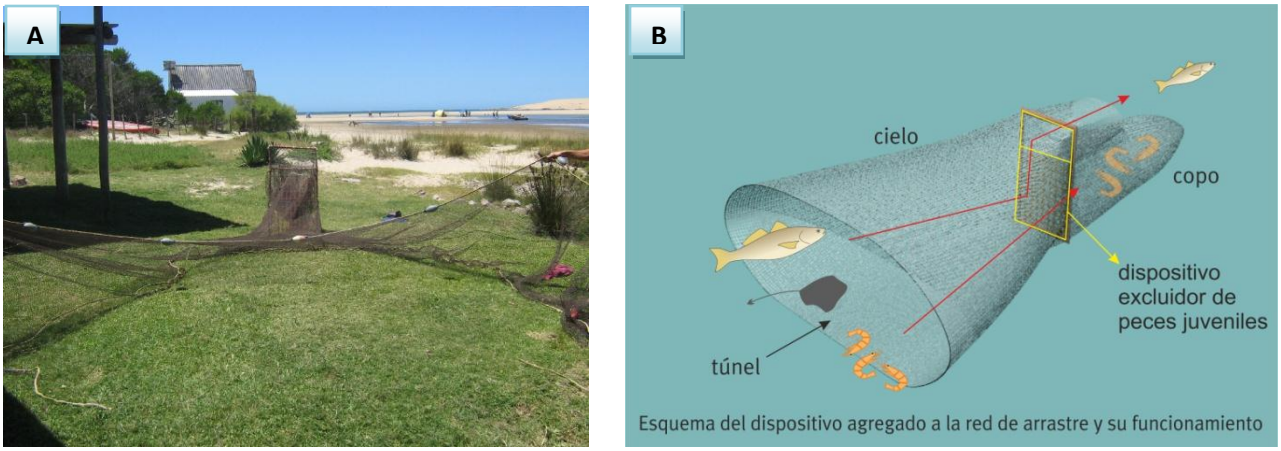

Figure 2.
A) Artisanal trawling net with DEPEJU. **B)** Schematic representation of the DEPEJU selecting shrimps and allowing fishes to escape.

Outputs and Results

Acording to the objective of testing a recently developed by catch reduction device (objective 1 and 2). We performed a total of 30 trawls in Barra de Valizas, capturing more than 30 species of fishes, of which >20 where bonny fishes and 7 where condryctians (Table 1 appendix). Based in data from 10 fishing events using the DEPEJU, total catch biomass did not differ between the common and the modified nets (Figure 3).

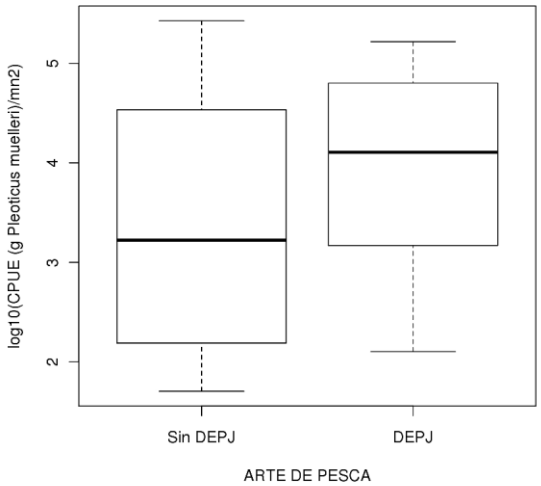

Figure 3. - Box plot with the average biomass of *Pleoticus muelleri* captured in the common net (Sin DEPJ) and the net with DEPEJU included (DEPJ).

The fraction of shrimp escaped when DEPEJU was approximately 30%, while the escape of fish was around 70%, with higher percentages forrays (90%) and lower for bony fish (59%). The excluding index (IE) was fairly low for shrimps, with a mode in 0.3 and a secondary peak at 1 (Figure 4). It is worth to mention that those events were related to very low shrimp capture. It can be concluded that the DEPEJU is efficient with regard to the escape of fish, but the fraction of shrimp escaping is high (Figure 5).

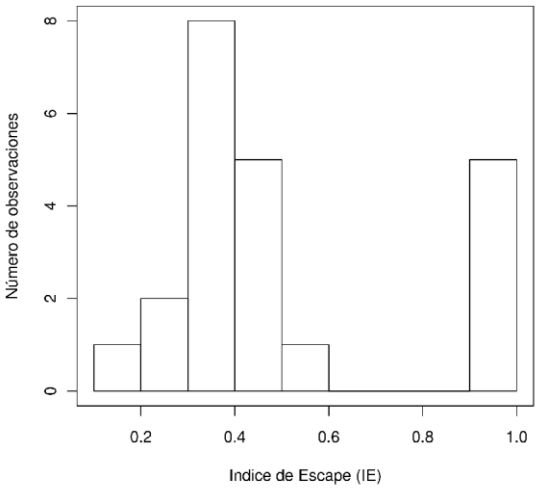

Figure 4. - Excluding index for the red shrimp (*Pleoticus muelleri*) captured in the Atlantic coastal zone.

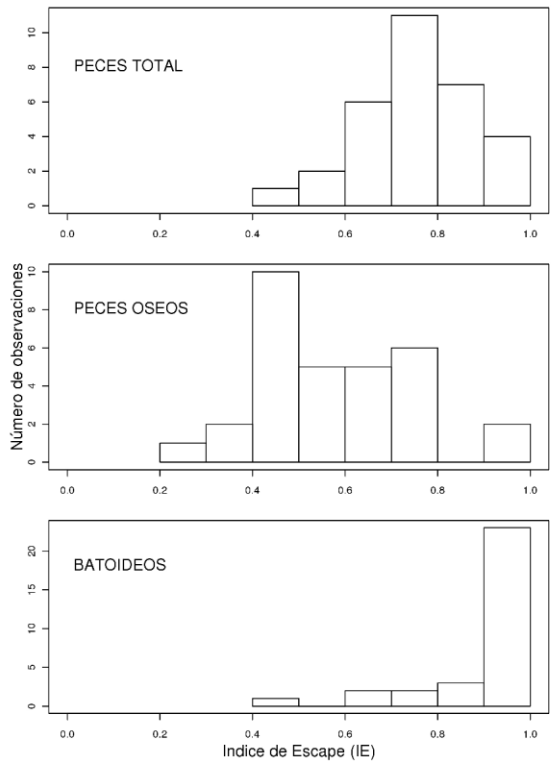

Figure 5. - Excluding index for fishes. Upper panel represent the distribution of the IE for total fishes, middle for bonny fishes and lower panel represent the distribution of batoideans (mostly rays). Notice the high fraction of escapement of batoideans, most of them qualified as endangered by UICN.

The device was tested not only by scientists, but also by fisherman during the evaluation period. They approved the functioning of the device in terms of fishing operations. Besides, they found easy and cheap to implement a similar device on their nets, in that way they do not need to be trained to install it. They evaluated the capture when using the DEPEJU as "cleaner"; which means that there is less by-catch to sort. Thus it reduces the amount of time used to manually separate the fish and invertebrates from the marketable shrimps.

After a set of evaluations, we modified the DEPEJU together with fishermen, changing the selection grid size and colour, in order to try to diminish the fraction of shrimps escaping from the net (Figure 6). However, we could not evaluate the new design.

We generated an inventory of fish and macro invertebrate species of the zone (objective 3). The organisms are listed in the appendix, and most of them are ready to be included in the Ichtyological collection of the Natural History Museum in Uruguay. We classified species according to its economic relevance for Uruguay and its conservation status as listed by UICN. Regarding the seasonal changes in abundance (Objective 4), we could not track the temporal variation of fishes and invertebrates, as weather did not allow performing on-board work in particular dates, and there are some gaps of information impossible to be filled.

As part of the objective related to raise local and regional interest in biodiversity (Objective 5), we elaborated a documentary movie, showing project development and main results that was presented in the meetings with fishermen and in some cinema festivals "Festival CINEconCIENCIA", "Cine Universitario", "muestra Documentales en la Frontera", "Luis Pugliese" and in a series of talks about fisheries organized in the National youth institute in the center of Montevideo.

We performed four meetings with all the community to discuss the efficiency of the DEPEJU and the ways to improve it that were very successful in number of fishermen involved and the results achieved. These meetings consolidated the relationship with fishermen and among them. There were ca. seven informal meetings with fisherman in which we evaluated and improved the net together.

Figure 6. - Fishermen and local people sharing knowledge gained during the project.

According to the objective related to educational activities (Objective 5). An education program was carried out in Valizas school and high-school. It consisted in a total of eight visits. It was done with preschool children from 1 to 6th grade, and high school students from 7th to 9th grade, totalizing 32 workshops. As an activity included in the educational program, we created a puppet show with the participation of local artist, school teachers, students and the scientific team. The students were the master of puppets in a celebration made at school at the end of the year (see appendix).
As a way to display and return the acquired knowledge it was made a model representing the seabed of the coastal studied area. This model was used as a valuable educational material (See appendix) that helped to show to Childs and general public marine organisms.

According to the objective related to contribute to improve MPA management (Objective 6). We were invited to participate in a consultancy to the governmental agency that regulates the national system of protected areas (SNAP). In the workshop, we identified key species and ecosystem processes in the protected area of Cabo Polonio. This is a highly relevant output since the only information on coastal marine fishes and macro invertebrates was obtained in the course of the present project.

Achievements and Impacts

We reached a very nice relationship with fishermen which allowed us to share with us their empirical and traditional knowledge. Fishermen were crucial in the testing and improving the selective device. This is crucial since it generates a precedent of successful cooperation among investigators, managers and fishermen. During the process, almost 35fishermen get involved directly in any of the conservation issues (for example, the importance of reducing by-catch), while scientists understand fishermen activities as a way of living and recognice economic aspects of conservation. Economic issues are generally neglected by scientist, thus impeding the inclusion of this very important variable in designign management strategies. Thus, we believe this is a critical achievement of the project which will allow us to try to work close together with economist or social workers in order to include this economical aspect of conservation. As a technical achievement, we tested the DEPEJU, and modified it as function of the results obtained. We also obtained samples of organisms that, despite common, they were absent from the collection of the Uruguayan Natural History Museum. In this way, we made a great contribution to the biodiversity heritage of the country.

In the educational axis, we raise concern on biodiversity issues in Valizas. This was achieved in different instances and with different public. The relationship with head teacher and teachers was very fluent and coordinated which allowed to develop a full educational programme which was kindly transmitted to the kids. As an example, students from high school participated in a sampling trip, performed scientific activities and then wrote a scientific report following the scientific method. The students were able to discover the value of biodiversity and cultural diversity by their own in a very enthusiastic way. By doing this, students and teachers get involved in the conservation activities planned in the objectives of this project.
A very relevant aspect of this small town was that project activities involved two or more generations of local people as for example an artisanal fisherman was shrimp-fishing and evaluating the DEPEJU while its grandchildren was involved in educational activities in the school. The climax of the educational activities was the marine biodiversity puppet show that we organized with childrens in the school. The presentation congregated most of the people of the town in the end of the year party.
In summary, we believed we have successfully achieved most of the planned objectives of this project. In some cases, we were not able to meet the objectives, but in others, the outcomes were fairly above our expectations, as in the case of the puppet show or the biodiversity exposition.
The DEPEJU was not as efficient as expected, but we provided a cooperative framework among scientifics, managers and fishermen towards a co- management of this fishery. We believe a future direction is to improve the DEPEJU in order to reduce the loss of shrimps, and seek for an eco-labelling which allow fishermen to increase the incomes despite the loss of shrimps when using DEPEJU.

Conclusion

This project was able to effectively raise concern about biodiversity issues at different scales. At the local scale, we worked together with fishermen in the evaluation of a DEPEJU implemented in the trawling nets, while exchanging traditional and scientific knowledge. The educational programme covered the full range of students of the town, thus incorporating ecosystem concepts in the formal education in an interactive and didactic way. At the national scale, we participated in the identification of key species and processes for the management plan of the Cabo Polonio area, which is the first marine protected area in the country. In this vein, we provided the first scientific information on marine species for the zone. Moreover, the explicit participation of the national fishery management institution provides a favourable framework for the implementation of co- management actions in this fishery. Those management actions could include the use of the selective device in the fishingnets as a way to diminish biodiversity impact of this fishery and on-board work for fishermen. The challenge for future steps are to improve the design of the DEPEJU, diminishing the amount of shrimps escaping and the eco-labeling of the fishery coupled to a marketing strategy to get better economic incomes for the fishermen.

Problems encountered and lessons learnt

The team improved during the course of the project the capacity to organize and coordinate field trips and our relationship with fishermen. There is an unresolved logistic problem caused by weather. In some of the field trips it was not possible to test the DEPEJU due to unexpected bad weather. Another fishing-related problem was the absence of shrimps in some seasons. Thus the DEPEJU selective efficiency on shrimps could not be adequately evaluated in some of the field trips.

One unexpected problem we faced was the lack of adequate glass container for conserving material in the collection. We solved the problem by making regular flasks collection campaigns among relatives. This is far from ideal as it limits our capacity to deliver organism to the collections.

In some circumstances we changed the planned activities for high school students because we identified lack of enthusiasm. This was very challenging since it obligate us to be creative in situ.

One of the weakest results was in the area of communication, where we planned to develop a radio programme together with the local community. We coordinate activities with some colleagues with expertise in communication sciences to produce and execute the program. However, we were not able to coordinate activities as to get the program ready before project end.

In order to work with people in conservation activities, it is crucial to plan for a fairly high amount of time to comprehend the other persons. It is imperative to respect the different perceptions and to visualize other's way of thinking. We think this is the most important lesson we learned during the course of this project.

In the future

We have consolidated a group of young scientists involved in conservation activities. We are now working as collaborators of the Biodiversity and Conservation Area of the National History Museum of Uruguay. We are basing our efforts in international conservation funding, as local support for conservation activities is scarce. However, the relationship generated with local people is a very important and valuable skill gained through the project, which facilitates the planning of new conservation activities. The generation of a local meeting point and biodiversity center is highly necessary and welcomed, both by local people and scientist. This center plans to merge, artisanal production, biodiversity exposition and local costumes using a win-win strategy. Another facet necessary for conservation is the improvement of the fishing gear, despite substantial improvement done, a decrease in the fraction of escaping shrimps is needed together with eco-labelling of the product in order to get better market prices and so a decrease in the by catch captured.

Appendices

A full account of income and expenditure can be found in "Fiancial_report_Segura_0624110_Uruguay_Shrimp.xls".

Photos, radio interviews and the movie of the puppet show are attached

List of recorded species

Table with species list registered in the course of the project in Barra de valizas, Uruguay. Species name, common name economic importance in Uruguay and its categorization in UICN is provided.

Specie	Common name	Economic importance	UICN category
Anchoa marinii	Anchoa	No	*
Balistes capriscus	Ballesta	No	*
Brevoortia aurea	Lacha	Si	*
Conger orbignyanus	Congrio	No	*
Cynoscion guatucupa	Pescadilla de calada	Si	*
Eucinostomus gula	Mojarra	No	*
Genidens barbus	Mochuelo	No	*
Lagocephalus laevigatus	Tambor	No	*
Macrodon ancylodon	Pescadilla de red	Si	*
Menticirrhus americanus	Burriqueta	Si	*
Micropogonias furnieri	Corvina	Si	*
Monacanthus ciliatus	Ballesta	No	*
Mustelus schmitti	Gatuzo	Si	Endangered
Myliobatis goodei	Chucho	Si	Data deficient
Oncopterus darwinii	Lenguado	Si	*
Paralichthys orbignyanus	Lenguado	Si	*
Paralonchurus brasiliensis	Córvalo	No	*
Parona signata	Palometa	Si	*
Peprilus paru	Ñata	No	Least concern
Percophis brasiliensis	Ajorreal	No	*
Pomatomus saltatrix	Anchoa de banco	Si	*
Porichthys porosissimus	Bagre sapo luminoso	No	*
Prionotus punctatus	Testolín	No	*
Rhinobatos horkelii	Guitarra	No	Critically endangered
Selene sp.	-	No	*
Squatina guggenheim	Angelito	Si	Endangered
Stellifer rastrifer	-	No	*
Stromateus brasiliensis	Cagavino	No	*
Symphurus sp.	Lengüita	No	*
Sympterygia acuta	Raya	No	Vulnerable
Sympterygia bonapartii	Raya marmorada	No	Data deficient
Discopyge tschudii	Torpedo	No	*

Trachinotus sp.	-	No	*	*Urophycis*
brasiliensis	Brótola	Si	*	*Zapteryx*
brevirostris	Guitarra ñata	No	Vulnerable	

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PAPERS IN PREPARATION

Segura A.M, Trinchin R., Rabellino J., Arismendi E., Scarabino F, & Carranza A. A multi specific coastal nursery ground in the South western Atlantic. To be submitted to Journal of coastal research

Segura A.M., Barreiro M., Ortega L., Scarabino F., Fabiano G. & Carranza A. Climate variability

promotes unusual biological events in the fish assemblage of the Uruguayan shelf. To be submitted to Global change biology.

Segura A.M, Trinchin R., Rabellino J., Scarabino F., & Carranza A. A cooperative design and evaluation of a small scale fish excluder device implemented in a shrimp trawling net. To be submitted to Fisheries research

Arismendi E., Lazaro, M. & Segura A.M. Perceptions of the environment from scientist, fishermen and managers: are they so different?.

COMUNICATION OUTPUTS

We performed two interviews with local radios.

Address list and web links

An annotated list of useful names, addresses and websites
http://robinpuntadeldiablo.blogspot.com/

Facebook: Robin Uruguay CLP

Distribution list

We distributed a copy of the final report to the Scientific Council of the National History Museum
We also send a copy to the executive director of Vida Silvestre UY, Mariana Ríos.Ing. Agr. Guillermo Scarlato from SNAP project; Lic. Mario Batallés which is incharged of protected Areas and biodiversity (DINAMA-MVOTMA) and MSc. Victor Cantón Director of biodiversity and protected areas (DINAMA-MVOTMA). Joaquín Aldabe, chair of Birdlife international and from the group of biodiversity, environment and society (CURE-UdelaR)