

CENTRO CIENTÍFICO, TECNOLÓGICO Y EDUCATIVO ACUARIO DEL RÍO PARANÁ: FIRST EXPERIENCE OF ANIMAL WELFARE MEASUREMENT

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Located in Rosario, Santa Fe, the “Centro Científico, Tecnológico y Educativo Acuario del Río Paraná” is a state public initiative. Its purpose is the environmental conservation and the sustainable use of one of the most important and biodiverse freshwater system of the planet: the Paraná River and its wetlands. It is a multifunctional Center where education, science, environment and biodiversity are intertwined with the community in an innovative way. We open our doors on February 9, 2018.



The center integrates conservation, social responsibility, environmental awareness and scientific education through three guidelines:

- Education: oriented to dissemination and scientific education about the ecosystem of the Parana’s wetlands and the social appropriation of knowledge.
- Science: oriented to know the biodiversity and to establish bases for the conservation of the natural resources promoting, in addition, the aquaculture.
- Social: oriented to build ties with communities on environmental conservation and culture, through the development of joint programs.

Structurally, it has a research area, an educational area with 10 aquariums (180,000 liters) that represent different environments of the Paraná River and contain over a 100 native fish species, an interactive space with technological devices and an auditorium. It also has a native park with more than 50 species of trees representing 4 ecoregions present in Santa Fe.



The visitors of the Center make a guided tour of 2 hours: 30 minutes in the native park, 30 minutes in the laboratories, 45 minutes in the sample and educational devices and 15 minutes dedicated to establish a commitment to the care of the ecosystem.

The animal welfare and environmental enrichment program (BEA) is one of the activities on which we focuses, being part of the Training Path of the residents who work together with aquarists, technicians and the scientific area. The program is based on the 5 domains model (Mellor y Beausoleil, 2015).

It should be noted that the methodology is in a period of testing and continuous improvement. The aim is to implement a constant and practical monitoring of systems and animals.

For the first experience we worked with 4 species chosen according to the availability of information, since for many of our native species it is extremely scarce.

- Dorado (*Salminus brasiliensis*) – specimen “Pancha”
- River stingray (*Potamotrygon motoro*) – specimen “Úrsula”
- Red belly piranhas (*Pygocentrus nattereri*) – School
- Dimerus (*Cichlasoma dimerus*) – School

Each BEA team was responsible for one species and developed an investigation for 6 months, in order to also unify and expand our specific knowledge of each species.

How we measure animal welfare:

In an own development (Ing. Clara Mitchell), we establish 13 indicators. Each one has a different impact on the animal welfare and affects one or more domains.

- Institutional: procedures, good practices and staff training and contingency plans.
- Aquarium: water, photoperiod, shelters and stocking density.
- Animal or school: intake, food, nutritional status, health status, animal behavior and environmental enrichment.

Indicators are combined in a formula that allows an approximation to the general welfare of the animal and where improvements can be generated systematically; all through a practical, orderly and relatively simple approach.

Environment = 0,5*Water + 0,3*Stocking Density + 0,1*Shelters + 0.1*Photoperiod

Nutrition = 0,4*Intake + 0,3*Food + 0,3*Nutritional status

Health = Health status

Behavior = Behavior + Enrichment

BEA = (0,3*(Proced+GP+Contig)+0,7*(Environment+Nutrition+Health+Behavior))/13,2

The indicators and their factors can vary if the species studied justifies it. To take into account certain specific issues, we can penalize an indicator.

Values that each indicator can take:

Procedures:

- 0: there are no procedures
- 1: procedures in development
- 2: procedures in implementation
- 3: continuous improvement procedures

Good practices and staff training:

- 0: without training or good practices
- 1: initial training
- 2: advanced training
- 3: permanent training

Contingency plans:

- 0: without contingency plans

- 1: contingency plans in development
- 2: contingency plans in implementation
- 3: defined and clear contingency plans. Posters and procedure available for consultation

Shelters:

0: there are no shelters and the species needs them or there is not enough for less than 30% of the fish in the aquarium

- 1: there are shelters for 30 to 60% of the fish that need it.
- 2: there are shelters for more than 60% of the fish that need it, but not for all.
- 3: there are shelters for all the fish that need it or the fish do not need any

Food intake:

0: animal is not eating (for a period that is considered worrisome).

- 1: the animal wants to eat, but is not reaching any food
- 2: the animal reaches the food but is still hungry
- 3: the animal proves to be satisfied

Food:

- 1: food is provided, but it is not perfect for the species
- 2: the best possible food is provided, but it is not supplied in the proper way
- 3: the best food is provided and in the best possible way for the species and includes enriched diets

Nutritional status:

- 1: the animal is thin or obese, outside the parameters expected for the species.
- 2: the animal is losing or gaining weight/size towards the parameters expected for the species.
- 3: the animal's weight/size is stable and is within the normal parameters for the species.

For this indicator we had to develop an objective alternative method because we cannot weigh or measure the animals.

Health status:

- 0: the animal is sick with a diagnose
- 1: the animal has clear symptoms of disease and/or important injuries
- 2: the animal could be presenting some symptoms
- 3: the animal is healthy and we are sure that it does not present any symptoms of diseases

Photoperiod:

- 0: the current photoperiod is harmful for the species
- 1: the current photoperiod is not beneficial for the species
- 2: The current photoperiod is acceptable for the species
- 3: The current photoperiod is favorable for the species

Behavior: natural or desired / unnatural or unwanted / undefined

- 0: the animal presents only unwanted behaviors
- 1: Percentage of unwanted behavior greater than 33%
- 2: percentage of undefined behavior greater than 33%
- 3: percentage of desired behaviors greater than 33%

Enrichment:

- 0: there is not yet an enrichment project in the aquarium
- 1: there is at least one enrichment project but for other aquarium species and it does not have an impact on the species studied.
- 2: there is, at least, an enrichment project for other aquarium species, but an impact on the fish studied is seen.
- 3: there is, at least, an enrichment project for the evaluated species

Stocking Density:

In this case we must take into account several issues:

- Biomass of fish per aquarium in relation to the filtering capacity of the life system.
- Number of individuals of the same species preferred by the fish (school or solitary).

Note: the interaction with other species in the aquarium will be taken into account in the indicator “behavior” where we detect if there is violence or aggression between species.

Because the current fish load is still below the maximum capacity of the aquariums and we are not going to increase so much the amount of fish, we will consider only the second item for this experience. Thus the scale for this indicator is:

- 1: the number of individuals of the same species generates great discomfort in the animal
- 2: the animal is not comfortable with the number of individuals of the same species
- 3: the animal is comfortable with the number of individuals of the same species

Water parameters:

$$\text{Water} = 0,277 * \text{OD} + 0,167 * \text{pH} + 0,222 * \text{Temperature} + 0,111 * \text{Nitrites} + 0,111 * \text{Nitrates} + 0,055 * \text{Kh} + 0,055 * \text{Gh}$$

It should be noted that the values that take OD, pH, Temperature, Nitrites, Nitrates, Kh and Gh are not the values of the measured parameters, but a comparison between the ideal range, survival range and minimum survival range. Therefore, each water parameter takes a value from 0 to 3 according to the following scale:

0: outside of the survival range of the animal

1: Minimum conditions

2: within the acceptable range

3: within the ideal range

Let's do it:

So we start this project, which still has much to improve and discover...

In the case of the first 3 indicators (procedures, good practices and contingency plans) they are still in development, so for this first experience they take a value equal to 1.

Water Indicator:

Dimerus - aquarium A9

Parameter	Unit	Ideal rank	Real value	Result
Temperature	°C	18 - 30	23,83	3
pH		6,8 - 8	7,75	3
OD	ppm	more than 5	7,46	3
Kh		0 - 12	3,75	3
Gh		0 - 12	4,25	3
Nitrates	mg/L	5 - 10	10,22	2
Nitrites	mg/L	0 - 1	0,00	3
Ammonia	mg/L	less than 0,2	0,18	3
Water =				2,883

Photoperiod:

The photoperiod depends mainly on the number of hours we have visitors. We analyze how it affects the animal and if it is serious, an improvement proposal is made. In this indicator we also take into account different lighting issues.

Shelters:

Ursula's case: the river stingrays seek refuge by burying themselves in the sand. In the aquarium "Laguna" there is a surface of sand for 4 of the 6 animals (67%) – 3 stingrays and 3 soles. However we also noted that she uses the plants and decoration to get out of the public view. Therefore, the value that this indicator has taken is 2.

Stocking Density:

Pancha's case: this species tends to remain in school as juveniles and then have a more solitary life when they grow up. Pancha shares the aquarium A1 – "Canal", the largest aquarium, with 3 other dorados that are considerably smaller in size. Persecutions are frequent and she has established a territory that the others do not invade, demonstrating that clearly she has the greater hierarchy. However, it would not be profitable for her to be absolutely alone and, even taking into account the other species, she has plenty of room to swim. Therefore, we concluded that she does not show any type of discomfort and that the indicator takes a value of 3.

Food:

To feed a 100 different species we have 15 types of balanced commercial food items (aquaculture and aquarium), meat (4 species of fish) with vitamin additives, fruits and vegetables, earthworms and live or frozen fish. In addition, in certain aquariums there are natural plants that are consumed by some species.

Red belly piranhas' case: they are fed mainly with meat cut into large pieces but frozen mojarras are also added. They share the aquarium with "mojarras", but no depredation is detected. Some studies mention that vegetable remains have been found in the stomach content of this species, but it is under discussion if it is due to accidental intake in the hunt or if they are actually feeding on plants. It was decided that the value taken by this indicator is 3.

Ursula's case: she is fed with earthworms, frozen fish and pieces of meat. In addition, it has been detected in some opportunity predation in the aquarium. Therefore, it was decided that the value that this index takes for it is 3.

Food intake:

Periodically we record the animal's food intake in the different aquariums. The animal welfare team analyzes records, especially if there are doubts about a period of voluntary fasting of the animal.

Health status:

This indicator is decided after analyzing the records of animal observations, mortality, food intake, nutritional status, behaviors and others. In the slightest doubt, the animal is kept under constant observation and this indicator takes a value of 2.

Enrichment:

In Ursula's case, an environmental enrichment project with natural plants is being carried out in the aquarium. Although it is designed for other species, it has an impact on Ursula that takes refuge in them. Food is also being enriched through the incorporation of different fruits and vegetables. Ursula does not feed on them, but we constantly see her in exploratory behavior. Therefore, it is decided that the value of this indicator for Ursula is 2.

Nutritional status:

For the objective measurement of this indicator, alternative methods had to be created since the animals are captured only when strictly necessary, discarding protocols such as weighing and / or blood extraction.

Pancha's case: in this species the maximum height fits about 3.3 to 3.7 times in the standard length. Therefore, we took 30 pictures of Pancha and the other individuals of this species, calculate long/high with a software and averaged the 30 values. If this ratio is between 3.3 and 3.7 the animal would be within normal parameters; below 3.3 is overweight and above 3.7 is thin. This indicator adjusted well enough to the observable nutritional status of the animals and we will continue monitoring over time to detect trends as quickly as possible.

For species that this data is not available, we considered photographs of animals in their natural environment and proportions were calculated and averaged. This method is still being tested to determine if it is sufficiently reliable and representative of the nutritional status of the animal.

Behavior:

Red belly piranha's case: after the observation of the aquariums it was possible to identify some of the members of this school; they were named "Mancha", "Catalina" and "quintillizas". The first version of the etogram was made and the minutes in each type of behavior and/or the frequencies were recorded.

These animals did not present any behavior that we could define as unnatural or unwanted, but analyzing the data we noted that during 70% of the time they were "at rest"; it is not known if this proportion would be natural, so several experiments are planned to evaluate the response of the animals: increase the stream and increase shelters, for example. Meanwhile we decided to penalize the value that would have been 3 and take it as 2.

Final measurement example:

Dimerus - aquarium A9

Indice	Value	Indice	Value
Procedures	1	Intake	3
Good practices and staff training	1	Food	3
Contingency plans	1	Nutritional status	3
Water	2,883	Health status	3
Photoperiod	2	Behaviour	2
Shelters	3	Enrichment	1
Stocking Density	2		

General	3	max 9
Environment	2,5415	max 3
Nutrition	3	max 3
Health	3	max 3
Behavior	3	max 6
BEA =	68,02%	

Discussion:

At the end of this part of the process, possible environmental enrichment projects are developed. Once selected, made and after a period of time, we will measure their welfare again to ensure that the project or projects have been effective. At this time, we are improving the decorations of some aquariums to



increase the number of shelters, adding new types of food, improving the lighting of aquariums and changing some interactions with the animals.

Once a specimen or school ends this process, it is checked every two months or if there is a significant change in the aquarium. At the same time, new species or specimens are added to the program.

Some improvements for the following additions of species to the program:

- Stocking Density indicator: we must determine a more objective and efficient way to determine this indicator.
- We currently consider the 5th domain as a part and result of the 4 previous domains.
- The ethograms and their indicator can still be improved and deepened in order to obtain a more representative result.

As an institution, we must not forget that it is a process of continuous improvement that will be refined and improved over time, the measurements that are made and the new species that are entering the program.