

Some Aspects of Conservation
of
Pejerrey Resources in Lago Poopo

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1. Aim

Studies on feasibilities of conservation measures - hatchery operation, establishment of aquaculture research station - for pejerrey (B. bonariensis) resources in Lago Poopo, and of processing facilities for additional values on the pejerrey catches.

2. Date

From 13 November to 12 December, 1987

3. Location

Lago Poopo, Oruro, Bolivia

4. Environment

Lago Poopo is located between latitudes $18^{\circ}21'$ and $19^{\circ}10'S$. and between longitudes $66^{\circ}50'$ and $67^{\circ}24'$ W.. It occupies a very shallow depression in the Altiplano only a few meters below the general level of the surrounding land and is nowhere more than 6 m

(Forster, 1985). The mean surface area of the lake has not been exactly measured but estimated greater than 600 Km² in 1985 (Forster, 1985) or 2500 Km² at low stage (Encyclopaedia Britannica, 1970).

It is very shallow but wide lake and consequently susceptible to environmental factors in its limnological characters. The climate of the region is cold and arid with extreme temperatures in winter reaching several degrees below zero, and in summer, 20°C (Forster, 1985). The annual precipitation is around 300 mm and evaporation is of the order 1500 mm (Carmouze et al, 1977).

The main inflow to Lago Poopo is from Lago Titicaca via the Rio Desaguadero, and the only visible outlet moves underneath the sand and empties into the Sala de Coipasa via the Rio Lacajahuira. The larger part of the inflow of the lake seems to be evaporated providing the salinity high up to 7 - 20 ‰ (Min, Dec. 1987).

The drought and subsequent drying up of Lago Uru Uru and the considerable regression of Lago

Poopo in 1983 (Forster, 1985), and the inundation making the lake reach sometimes almost to Oruro, fully 30 mi. from the low-water shore (Encyclopaedia Britanica, 1970) are believed to be alternative and unisolated events. In addition to seasonal changes, fluctuations of limnological and fisheries-biological parameters of the lake can be extreme in such a shallow and confined lake.

5. Pejerrey Resources and Fishery

The pejerrey was first introduced to Lago Poopo in 1963 from the brackish waters of the River Plate basin. By 1965 an important fishery over the species had developed (Forster, 1985).

The pejerrey fishery in the lake is basically subsistent and carried out by about 900 fishermen resident along the shore of the lake. All of the fishermen are members of co-operatives.

The fishermen use small boats of 6-7 m long, which are made of galvanized iron sheet on wooden

frames and equipped with, in most cases, out-board engines. Some boats are mobilized by sails or by oars. Floating gill-nets of 0.9 m wide and 100 - 300 m long are used by one or two fishermen in a boat.

The annual catches of pejerrey from 1978 to 1987 from Lago Poopo are as follows:

| | Catch (tons) | Remarks |
|------|--------------|----------------|
| 1978 | 298 | |
| 1979 | 250 | |
| 1980 | 300 | |
| 1981 | 350 | |
| 1982 | 234 | |
| 1983 | - | Drought, fish- |
| 1984 | - | ing impossible |
| 1985 | 80 | |
| 1986 | 260 | |
| 1987 | 1,000 | Estimated |

Marketability of the pejerrey catches in domestic markets does not seem to be prosperous. The

Bolivian people is traditionally meat-eaters and fish consumption in domestic market is very small. In La Paz, the annual fish consumptions from 1981 to 1984 were ranged 840-1,700 tons. The pejerrey catches are sold at about one Boliviano (≠ 0.5 U.S. dollar) per Kg. by the fishermen. Because of the transportation problem, little of the fish can be sold out of Altiplano.

6. Pollution of Lago Poopo

There are heavy metal mines extensively scattered in the region of Altiplano. High concentration levels of various heavy metals have been detected in water, sediments and plant samples taken from a number of streams and rivers that flow into Lago Poopo (Beveridge, 1983). It is still not known what the relative proportions of heavy metals are entering the lake through erosion of mineralized outcrops and by industrial processing of ores (Forster, 1985). As shown in Table 1, 2, and 3, the concentration levels of a wide range of heavy metals and nutrients

in materials sampled from the confined lake are unusually high compared with available data from industrially contaminated lakes in North America and Europe. Concentrations of silver, cobalt, copper, chromium, manganese, nickel, and tin are 4-40 times higher in the fishes from Lago Poopo than those from Canadian lakes.

Table 1. The concentrations (mg/l) of dissolved nutrients in Lago Poopo and world range (Goldman and Horne, 1983)

| | Lago Poopo | World range |
|------------------|---------------|----------------|
| SiO ₂ | 95.0 - 124.0 | 0.3 - 26.0 |
| SO ₄ | 570.0 - 625.0 | 0.2 - 9,000.0 |
| Cl | 28.0 - 54.0 | 0.1 - 17,500.0 |
| NH ₄ | 0.2 - 7.6 | 0.0 - 2.5 |
| NO ₃ | 15.0 - 20.0 | 0.0 - 2.5 |
| PO ₄ | 20.3 - 47.5 | 0.0 - 0.23 |

Table 2. The concentrations (ppm) of dissolved metals in Lago Poopo and in world lakes (Forster and Wittmann, 1981)

| | Lago Poopo | World lakes |
|----|-------------|-------------|
| Pb | 0.06 - 0.71 | 0.0002 |
| Cu | 0 - 0.10 | 0.0018 |
| Ag | 0 - 0.11 | 0.0003 |
| Cd | 0 - 0.07 | 0.0007 |
| Co | 0.06 - 0.45 | 0.0005 |
| Ni | 0.03 - 0.59 | 0.0003 |
| Cr | 0 - 0.11 | 0.0005 |
| Sb | 0.50 - 2.90 | 0.0001 |
| Fe | 0.11 - 1.46 | 0.030 |
| Mn | 0.03 - 0.11 | 0.0005 |
| Zn | 0.07 - 17.0 | 0.0003 |

Table 3. The concentrations (ppm) of heavy metals in tissues of pejerrey from Lago Poopo (Mathis and Cummings, 1973) and in those from Canadian freshwaters (Uthe and Bligh, 1971).

| | Fish from Lago Poopo | Fish from Canadian freshwater |
|----|-------------------------|----------------------------------|
| Pb | 3.08 - 5.93 | 0.5 - |
| Cu | 1.65 - 3.81 | 0.70 - 1.28 |
| Ag | 0.38 - 0.50 | - |
| Cd | 0.13 - 0.53 | 0.05 - |
| Co | 0.57 - 1.14 | 0.03 - 0.45 |
| Ni | 0.65 - 2.72 | 0.2 - |
| Cr | 0.38 - 0.93 | 0.017 - 0.065 |
| Sb | 6.92 - 19.55 | 0.0022 - 0.0043 |
| Fe | 26.05 - 56.88 | - |
| Mn | 2.78 - 16.09 | 0.02 - 3.16 |
| Zn | 50.00 - 101.92 | 0.12 - 20 |
| Sn | 33.41 - 71.90 | 0.54 - 3.57 |

7. Requests of Bolivian Government and Fishermen

1) Government

- Support to establishing a research station for fisheries biological research on pejerrey resource in Lago Poopo
- Support to constructing an aquaculture research station or hatchery for pejerrey and trout in Poopo region and support to related feasibility study and research
- Support to constructing processing facility for pejerrey catch for exportation

2) Fishermen

- Training of fisheries techniques
- Help for blanket-purchase of fishing gears such as gill-net, outboard engine, and boat etc. through the fishermen's co-operative organization from Korean producers

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* Gill-net : 0.9 m wide, mesh size 1½", 2½"
and 3"

* Boat : Galvanized iron sheet on wooden
frame, 300 U.S. dollars

* Outboard engine : 14 Hp, 1,200 U.S. dollars

8. Trout hatchery in Lago Titicaca

Japanese government supported to construct a trout hatchery on the shore of Lago Titicaca. They carried out feasibility study in 1984, began to construct the hatchery in 1986 and completed in 1987. Japanese specialist will carry out pilot production from 1988 to 1989. Commercial production is scheduled from 1990.

Limnological and environmental characters of Lago Titicaca are quite different from those of Lago Poopo. Trout culture and resource conservation through hatchery operation will be feasible. Especially, the hatchery has also training facility for technique extension and research facility which would be serviceable.

Bolivian government wants a similar support by Korean government for the pejerrey resource in Lago Poopo just like Japanese government did in Lago Titicaca.

9. Conclusions

- 1) Support to construction of a research station and related research for pejerrey resource in Lago Poopo is not feasible. The constraints derived from the extreme fluctuations of ecological and limnological parameters on pejerrey resource in Lago Poopo is far away from any efforts for active conservation of the resource.
- 2) Support to construction of pejerrey processing facility for exportation is not feasible. The annual landing of the fish from Lago Poopo is less than 1,000 tons. The landing places of the fish are all scattered around the lake, and it takes hours from one place to another by truck through unpaved roads or

through muddy flats along the shore. And fishing seasons are irregular. These conditions provide relatively large incidental expenses for the processing procedures and decrease the rate of operation of the facility. Also the heavy metal contamination of the lake and the fish makes it difficult to export the fish products from the lake.

- 3) Support to construction of a research station or hatchery for trout and pejerrey in the Poopo region is not feasible. And development of aquaculture for these species is neither feasible. In the region there is no water resource enough in amount and in quality for fish culture. The size of the domestic market is small and the prices of the fishes are relatively low in comparison with the prices of the materials necessary for aquaculture. Most of materials for feed and construction, and gears must be imported.

- 4) To increase the income of the fishermen from their catch, they need technique for increasing additional value to their catch rather than techniques for increasing the catch itself.

Pejerrey was filleted, seasoned, and dried experimentally. The dried pejerrey was proper in taste and texture as a fish product. The procedures of drying fish are quite simple and do not need special facilities nor skills.

- 5) Help for blanket-purchase of fishing gears such as gill-net, boat and outboard engine etc. through the fishermen's co-operative organization from Korean producers would be useful if it is possible.

10. Recommendations

- 1) Limnological study and pollution monitoring system in Lago Poopo had better be initiated

in advance of any trial on conservation and aquaculture of pejerrey.

- 2) To increase additional value of the pejerrey catch, drying process would be reasonable. No special facility, skill, and materials are necessary. And the arid climate of Altiplano will help the fishermen. They can process their catch by themselves in their village yard.

An invitation of a proper person, who will work on extension service for the fishermen on his return, to Korea for training on the procedure of drying fish can be expected.

- 3) The request of the fishermen on the blanket purchase of the fishing gears made in Korea through their co-operative organization will help them and should be regarded if possible.