Introduced beavers modify species and trophic diversity of sub-Antarctic benthic communities in Cape Horn, Chile

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Figure 1: A beaver dam on the Mejillones River, Navarino Island.

INTRODUCTION

- The North American beaver (*Castor canadensis*) was introduced into southern South America in 1946.
- Current beaver populations in the Fuegian Archipelago are estimated at 115,000 individuals that are continuing to expand at a rate of 20-23% annually.[1]
- Beavers alter both the habitat and resources available to organisms in terrestrial and aquatic ecosystems and in so doing engineer both biotic communities and entire food webs (**Figure 1 & 2**).[2]
- This study focused on the alteration of aquatic ecosystems, including assemblage and food web modification, which are innovations in the study of the impacts of the beaver in southern Patagonia.
- In this context, we set out to quantify species- and trophic-level responses to beaver impact in sub-Antarctic stream food webs.

STUDY SITE

The study was conducted on Navarino Island, Chile found in one of the world's few remaining temperate forests in an almost pristine condition which are also the planet's southernmost forested ecosystem (**Figure 3**).

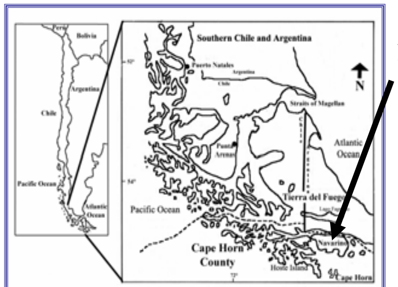

Figure 3: Navarino Island is a part of the Magallanes Region of Chile, south of Tierra del Fuego Island. (55ºS to 56ºS).

METHODS

- Four catchments (Robalo, Faraones, Estrella, and Mejillones Rivers) were utilized in this study.
- Each stream had three habitat types: a **natural** reach, a beaver **pond,** and a reach **downstream** of a beaver dam.
- Benthic assemblage and biomass were quantified using a core sampler once every season and length-mass regressions.
- Yearly averages of population-level (richness, diversity, density, and biomass) and trophic-level (total number of trophic links, number of trophic links per species, connectance and average node degrees) metrics of diversity were calculated and compared with a one-way ANOVA.

RESULTS

Table 1:	Mean (± SE)			ANOVA		
Species-level	**Natural**	**Beaver Pond**	**Down**	**d.f.**	**F**	**p**
Richness	10.4 (0.9)^{A}	**7.1 (0.4)** ^{B}	11.5 (0.9) ^{A}	2, 9	8.78	0.0012
Diversity	2 (0.1) ^{A}	**1.4 (0.1)** ^{B}	1.9 (0.1) ^{A}	2, 9	22.79	0.0003
Density	2611.5 (504.9) ^{A}	14350 (10380.6) ^{A}	5086.2 (1020.8) ^{A}	2, 9	2.855	0.08
Biomass	252.3 (89.4) ^{A}	**870.5 (179.8)** ^{B}	443 (68.2) ^{A}	2, 9	6.4714	0.0181
Trophic-level	**Natural**	**Beaver Pond**	**Down**	**d.f.**	**F**	**p**
Trophic Species	15.3 (1.8) ^{A}	**9.9 (0.9)** ^{B}	15.8 (1.2) ^{A}	2, 11	5.70	0.0252
Links	18.2 (2.4) ^{A}	14.8 (1.2) ^{A}	19.4 (1.6) ^{A}	2, 11	1.78	0.2232
Links/Species	1.2 (0.04) ^{A}	**1.5 (0.1)** ^{B}	1.2 (0.02) ^{A}	2, 11	23.81	0.0003
Connectance	1.4 (0.1) ^{A}	**2.3 (0.1)** ^{B}	1.5 (0.1) ^{A}	2, 11	24.10	0.0002
Node Degree	2.4 (0.1) ^{A}	**3 (0.1)** ^{B}	2.5 (0.04) ^{A}	2, 11	23.81	0.0003

1. Species-level diversity was significantly **reduced** in beaver ponds, compared to natural and downstream sites; however, **biomass** significantly **increased**. Measurements of trophic-level diversity showed that while beaver ponds **decreased** the **total species** and the **number of trophic links** in the food web, the food web **connectivity increased** (**Table 1**).

Table 2: Relative Biomass	Natural	Pond	Down	d.f.	F	p
Collector	51.4 (13.5) ^{A}	79.1 (7.5) ^{A}	55.6 (6) ^{A}	2, 11	2.4467	0.14
Scraper	14.4 (3.8) ^{A}	**0.4 (0.4)** ^{B}	11.1 (6.3) ^{A}	2, 11	15.072	0.00
Shredder	6.2 (0.3) ^{A}	**0.3 (0.1)** ^{B}	7.3 (3.3) ^{A}	2, 11	8.6563	0.01
Filterer	25.7 (12.7) ^{A}	**0.7 (0.6)** ^{B}	21.9 (11) ^{A}	2, 11	8.1176	0.01
Predator	2.3 (0.6) ^{A}	**19.5 (8.1)** ^{B}	4.2 (2.2) ^{A}	2, 9	4.2702	0.04
Parasite	0.0 (0.0) ^{A}	0.1 (0.1) ^{A}	0.0 (0.0) ^{A}	2, 11	0.3812	0.7

2. Total biomass of predators increased significantly in beaver ponds, while **total biomass of scraper, shredder, and filterer** functional groups was significantly **reduced** when compared to natural and downstream sites (**Table 2**).

Figure 2: An active beaver lodge and pond on the Mejillones River, Navarino Island.

Table 3:				Biomass (mg AFDM m^{-2})		
Order	**Family**	***Genus species***	**FFG**	**Natural**	**Pond**	**Down**
Amphipoda	Hyalellidae	*Hyalella simplex*	CG	30.7	33.87	25.6
Diptera	Chironomidae	Tanypodinae	P		15.3	2
		Non-Tanypodinae	CG	16.4	21.2	26.4
	Empididae	*Hemerodromia sp.*	P			1.1
	Simuliidae	*Gigantodax spp..*	F	20.7		19
	Tipulidae		CG	4.1		2
Ephemeroptera	Leptophlebiidae	*Massarotellopsis irrarazavali*	Sc	5		4.9
	Baetidae	*Andesiops torrens*	Sc	3.9		3.2
Coleoptera	Elmidae	*Luchoelmis sp.*	Sc			1.1
Plecoptera	Gripopterygidae	*Rhithroperla rossi*	CG	3.7		7.5
Oligochaeta				5.4	26.6	4
Trichoptera	Glossosomatidae	*Matigoptila brevicornuta*	Sc	1.4		
	Limnephilidae	*Monocosmoecus hyadesi*	Sh	2.3		
Gastropoda	Lymneidae	*Lymnea sp.*	Sc	2.2		
		Sub-Total >1%		243.3	838.1	429.2
		Total Annual Biomass		252.3	864	443
		Percent of Taxa >1%		96%	97%	97%
		Richness		11	4	11

3. Richness of **important species** (>1% of total biomass) was also significantly **reduced** in beaver pond sites, compared to natural and downstream sites (**Table 3**).

CONCLUSIONS

1. Beavers impacted sub-Antarctic stream food webs by significantly changing macroinvertebrate community composition, functional feeding groups, and trophic diversity.
2. Beaver ponds had unique trophic networks with significant increases in the predator functional group, which essentially added a trophic level.
3. Although species richness decreased in beaver ponds, the connectivity of the trophic networks increased due to the increased importance of predators in the food web.

References:

1. (Skewes *et al.* 1999)
2. (McDowel and Naiman 1986)

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