SUPPLEMENTARY MATERIAL

SPOILING THE CONTENTS OF A FUTURE SPECIAL ISSUE

Salt marsh ecosystem services: Supplying forage for livestock

Livestock grazing in salt marshes began in prehistoric ages, and nowadays this traditional practice is still quite common all over the world. Grazing by domestic herbivores (e.g. cattle, sheep, goats and horses) usually alters the structure and the functioning of salt marsh communities, and in some cases affects the provision of multiple ecosystem services. Much is already known about the impact of livestock grazing, especially from studies in European and North American salt marshes, and one of the clearest conclusions is that this is a complex ecological process that, besides direct consumption, involves other non-tropic mechanisms, such as nutrient cycling and trampling.

Grasslands of the Pampas region in Argentina have been historically used as the main basis of food production. At the beginning of the post-colonial times, the livestock grazing was extensive, but later both agricultural and livestock production were intensified. This resulted in simplified and highly productive agro-ecosystems and the displacement of livestock farming towards marginal ecosystems (Viglizzo and Frank 2006). Since the beginning of the 19th century, some SW Atlantic salt marshes have been grazed at very low stocking rates, but grazing intensity is strongly increasing since the last massive expansion of soybean cultivation. Currently, cows, sheep, and horses graze in many of these salt marshes at moderate stocking rates. As in other grasslands around the world, to improve the forage quality, burning during winter is commonly used, resulting in landscape homogenization. Previous studies in these salt marshes show that livestock grazing and burning have ecological consequences, affecting soil salinity, the composition and structure of the vegetation (Di Bella et al. 2014) and animal biodiversity, particularly those that use the structure and food resources provided by salt marshes, such as foliar arthropods and salt marsh nesting birds (Cardoni et al. 2012). Moreover, all these effects may change according to plant community composition, grazing management, and along the salt marsh elevational gradient (Di Bella et al. 2014, Isacch and Cardoni 2011). However, so far, little is known about how salt marshes are responding to livestock grazing within the context of global climate change and how their ecosystem services are being modified. Regarding these topics, our work group is mainly interested in knowing how the increasing forage provision appropriation by livestock grazing can generate trade-offs with other ecosystem services (e.g. by affecting carbon sequestration, decomposition, and biodiversity) in salt marshes in the global climate change context. Thus, a few years ago we established long-term field experiments in different salt marshes with different elevations, edaphic conditions, stocking density and burning managements at cattle breeding farms from the Samborombón Bay. We expect to eventually learn about how different livestock management strategies affect salt marshes and their ecosystem services, and how these effects may interact with different global change drivers. But, as we will see next, questions of this kind are pushing us to perform experiments at larger temporal and spatial scales.

The challenge of changing the scale

The detection and quantification of impacts related to global change drivers are an evident prerequisite to project future scenarios and to develop mitigation strategies. But, despite this urgent necessity, changes and impacts are not always easy to detect, as they can occur suddenly, or at low rates. In addition, the structure and function of natural systems are usually quite dynamic, even under unaffected conditions (i.e. they can be highly variable in the temporal and spatial dimensions). This variability threatens effect detection through experimental manipulation, because of the low statistical power (high variances and small effects are a challenging combo). Thus, the goal of detection and quantification of possible impacts is generally far beyond the ones that a classic short-term research project can achieve. Most of the examples we discussed above, for example, are the result of field studies involving experimental plots at the scale of one or a few square meters, and generally lasting

1-3 years. These short-term and short-scale studies were adequate for answering the type of questions we were trying to answer, but are inadequate for most of the questions related to global change effects, that demand considering longer time series. We are thus trying to change the way we used to perform our research projects, and starting to design experiments whose duration allows us to include the temporal variability (i.e. decades). For example, we are performing a nutrient addition experiment, using 150 m^2 plots, that will last at least 10 years, allowing us to accommodate different complementary nested treatments in order to evaluate a variety of specific questions and to identify the drivers responsible for the fluctuations at shorter time scales. Long-term approaches, nevertheless, not only demand commitment, but also the stable provision of funds. In order to maximize efficiency in a context of limited resources, we are trying to use simple, inexpensive designs that are flexible, with room for additional complementary or nested studies.

Do as I say, no as I do? Southern salt marshes have a lot to say
As we noted in the main text, our examples describe the contribution of SW Atlantic salt marshes to different theories and hypotheses (driven by well-established generalizations). However, we want to strengthen that those examples were actually obtained from the Northern part of the SW Atlantic as these salt marshes have been more intensively studied and they are larger in extension. Nevertheless, salt marshes on the Southern part are quite different in terms of structure (and probably in terms of function). A great progress has already been made in our knowledge about their distribution, geomorphology and ecology (e.g. Isacch et al. 2006, Bortolus et al. 2009, Idaszkin et al. 2011, Ríos et al. 2019). We believe that results coming from those salt marshes will continue to trigger the discovery of other important differences and novel interactions, ultimately redefining the way in which we perceive salt marsh organization.

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