Response to “Whales Might Also Be an Important Component in Patagonian Fjord Ecosystems”

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Our contribution (Iriarte et al. 2010) focused on a more general vision, engulfing almost all Patagonian fjord and channel systems under the umbrella of “ecosystem services” (ES). Ecosystem services offer a promising means for aligning conservation, production and socio-economic goals, while simultaneously increasing human welfare and protecting biodiversity, engaging a wider range of places, people, policies, and financing resources. This approach allowed us to integrate organisms of all size spectra (from bacteria to whales) and all types of systems (from the headwaters of the forested watersheds downstream to the related pelagic and benthic coastal marine ecosystems). Furthermore, we gave particular emphasis in the assessment of selected ES, including water quality, carbon sinking and sequestration, the production of pelagic fisheries, and the impact of top predators in the Patagonian fjords. This conceptual model described some ES selected (e.g. water availability and regulation, nutrient cycle, food production, climate regulation) as functions of ecosystem processes (e.g. water reserve and flux, nutrient availability and recycling, carbon flux as energy, climate processes modulating biological processes) and forested watershed-fjord dynamics, human disturbances and climate change.

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Thus, these ES could be used in the design of comprehensive management recommendations.

Huckle-Gaete (2011) points out an interesting aspect, particularly in terms of carbon export (Pershing et al. 2010) and its impact on the tertiary level of consumers in oceanic upwelling trophic webs (Alava 2009), of the role of whales, when present, in semi-enclosed systems. Although not yet quantified, the role of whales in pelagic food webs associated with semi-enclosed Patagonian systems should be highly relevant in areas with enhanced water exchange between the adjacent coastal region and wide-open, relatively deep, semi-enclosed areas (i.e. Corcovado Gulf; Straits of Magellan). Abundant whales have often been observed in these systems, which seem to be important feeding and nursing grounds, during the productive season (austral spring and summer) (Huckle-Gaete et al. 2004). In addition, whales constitute a major mechanism for recycling iron through feeding on krill and the production of unconsolidated iron-rich faeces. The faecal iron content (145.9 mg kg^{-1}) has been reported to be 10 million times higher than in the surrounding Antarctic waters (Nicol et al. 2010). Thus, whales might contribute significantly to maintaining the sustained high primary production (PP) levels found in the area. Ideally, we would be able to calculate this contribution (expressed as maximum recycled iron in mg) by using an actual estimate of PP (this can be extrapolated from Iriarte et al. (2007) and González et al. (2010) and the number of whales per 1000 km^{-2} , considering the total carbon (in tons) that each of these large cetaceans are able to consume. Unfortunately, these calculations cannot be made given the current lack of relevant data.

Another fertilization mechanism not mentioned by Huckle-Gaete is the mixing effect exerted by whales in semi-enclosed systems. If vertically migrating organisms

such as krill can affect the physical structure of the upper ocean through turbulent mixing associated with their diurnal vertical migrations (Kunze et al. 2006; Kajita and Dabri 2009), whales could be expected to have a similar effect, disrupting the physical structure during swimming. The effects of whales and vertically migrating animals on ocean chemistry and physical structures may affect the whole system in different ways and on different spatial/temporal scales. Among others, certain euphausiid species (i.e. *Euphausia vallentini*) and blue whales (*Balaenoptera musculus*) seem to be key components in maintaining high levels of PP during the productive season, thereby stabilizing the food web structure in some Patagonia fjord systems.

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