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Commentary: Variability in Shelf Sedimentation in Response to Fluvial Sediment Supply and Coastal Erosion Over the Past 1,000 Years in Monterey Bay, CA, United States

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A Commentary on

Variability in Shelf Sedimentation in Response to Fluvial Sediment Supply and Coastal Erosion Over the Past 1,000 Years in Monterey Bay, CA, United States
by Carlin, J., Addison, J., Wagner, A., Schwartz, V., Hayward, J., and Severin, V. (2019). Front. Earth Sci. 7:113. doi: 10.3389/feart.2019.00113

Recently, Carlin et al. (2019) published interpretations of several sediment cores obtained from the mid-to-outer continental shelf of Monterey Bay, California. Their primary conclusions were made from the fractions of total sand (>63 microns) and "littoral" sand (>180 microns) in four coring sites that recorded sedimentation up to ∼1000 years BP. Total sand was attributed to variations in river sediment supply and "littoral" sand to variations in coastal erosion.

Unfortunately, these interpretations neglected documented sediment transport mechanisms and pathways, such as river-sourced sediment gravity flows, overlooked anthropogenic effects to seafloor sediment, such as bottom trawling, and provided an unsatisfactory understanding of watershed processes. As such, the conclusions are speculative at best, and very likely incorrect.

We address their "coastal erosion" conclusion first, which is highlighted prominently throughout the paper. The authors' underlying assumptions were that: (i) "littoral" sands found in the cores must be recently derived from the region's littoral cells and (ii) transport mechanisms, related to coastal erosion, that brought these sands from the coast to the mid-to-outer shelf (60–100 m water depth). These assumptions are incorrect. First, sands with "littoral" grain sizes (i.e., >180 microns) are found in a diversity of settings throughout the inner and outer Monterey Bay. For example, sandy settings include offshore bedrock reef aprons, rippled-scour depressions, sand waves, and the majority of the outer shelf of the bay (Eittreim et al., 2002; Storlazzi and Reid, 2010; Hallenbeck et al., 2012; Golden, 2013; Rosenberger et al., 2019). All of these sand deposits are potential sources to the four coring sites, in contrast with the first Carlin et al. (2019) assumption. Second, no mechanism for transporting sand from the coast to mid-to-outer shelf was provided, and other well-documented and more likely pathways and processes were not considered, including:

- Direct fluvial-to-shelf transport from mud-dominated gravity currents, river-derived hyperpycnal flows, and wave remobilization of river-derived deposits (Wright et al., 2001; Fan et al., 2004; Warrick et al., 2008, 2013; Warrick and Barnard, 2012; Steel et al., 2016).
- Sediment transport from internal waves—including landward transport of slope and outer shelf sands and seaward transport of inner shelf sands—as documented in Monterey Bay and similar settings (Cacchione et al., 2002; Noble and Xu, 2003; Storlazzi et al., 2003; Cheriton et al., 2014; Rosenberger et al., 2016; Boegman and Stastna, 2019).
- Transport of sands from feeding and excretion of the abundant wildlife of the region, including gray whales (Cacchione et al., 1987), seabirds and bottom-feeding fish.
- Modification of seafloor sediment grain-size distributions from bottom trawling (ONMS, 2015; Oberle et al., 2018).

Importantly, Carlin et al. (2019) document changes in the "littoral" sand fractions present in the sediment over time, notably an increase in these fractions between 1970 and 1985 (see their Figure 9). This would require changes to either the rates of sand supply or the physical conditions driving sand transport.

Evidence for changes in sediment supply rates and physical conditions of Monterey Bay abounds. For example, the 1982–1983 winters had record river sediment fluxes in the region (Hicks and Inman, 1987) that fundamentally increased landscape sand production (East et al., 2018). Internal waves are dependent on ocean water densities, and temperature-based variability of the region's ocean water density, including significant warming after 1977, is well-documented (Field et al., 2006a,b). Biological feeding patterns respond to a range of environmental factors, including food abundance and distribution as well as water temperatures and human impacts, all of which have changed markedly during the twenty century (Ueber and MacCall, 1992; Jackson et al., 2001; Field et al., 2006b; Stewart et al., 2014). Lastly, the location and intensity of bottom trawling has changed markedly with time in Monterey Bay (ONMS, 2015).

Although there is insufficient space to analyze these sediment transport processes and pathways and their changes with time, we note that, unlike the coastal erosion mechanism suggested by Carlin et al. (2019), these pathways have been documented with observations and/or physical process studies as shown with examples cited herein.

We highlight three other matters from Carlin et al. (2019). First, it is suggested that total sand within shelf sedimentary deposits is monotonically related to fluvial supply. This simple model (higher river discharge results in more sand on the shelf) overlooked sedimentation processes of the well-documented Eel River, California system (e.g., Fan et al., 2004), for which higher river discharge results in *lower* sand fractions on the shelf. Thus, the simple model of Carlin et al. (2019) is either incorrect or incomplete because it neglected processes, including fluvial export, gravity-driven transport of fluid muds, and winnowing and resuspension of shelf sediments by ocean waves as detailed in Fan et al. (2004).

Second, Carlin et al. (2019) concluded that dams have increased coastal erosion, which, in turn, increased "littoral" sand input to three of the four coring sites. In contrast, Willis and Griggs (2003) report that dams have reduced sand supply to the "Santa Cruz" littoral cell by only 3%, thereby having negligible effects on coastal erosion. Because this littoral cell would be the "source" of coastal erosion for the three coring sites in question, the authors' conclusion is unsupported by previous findings.

Third, the authors suggested that river sediment inputs since the 1970s were both unusually high because the total sand fractions were high and unusually low because "littoral" sand fractions were also high. Both cannot be true. The former was attributed to "anthropogenic modification to sediment dispersal systems" that increased river sand discharge, and the latter was attributed to the effects of dams on decreasing river sediment discharge thereby accelerating coastal erosion. These suggestions are inconsistent with studies of the Monterey region's rivers that find coherence in the discharge relationships of sand fractions (Gray et al., 2014; East et al., 2018).

Thus, the primary conclusions of Carlin et al. (2019) are inconsistent with a large body of literature, and alternative hypotheses, such as those highlighted here, were not evaluated.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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