diatom assemblage. This assemblage is present in the bottom half of the core from about 73 cm (around 1750 AD) to 33 cm and contains *Actinopthychus senarius, Cocconeis* sp., *Fragilariopsis doliolus* and *Thalassiosira eccentrica* as subordinated species. A second assemblage is found from about 33 cm (1850 AD) to 26 cm, and is dominated by the centric diatom *Skeletonema costatum,* with *Pseudo-nitzschia pungens, Pseudo-nitzschia australis* and *Prosbocia alata* as subdominant species. The third assemblage extends from about 26 cm (1880 AD) to 10 cm and contains abundant *Thalassionema frauenfeldii* and *T. bacillare* and a presence of *Coscinodiscus argus*. Finally, the fourth diatom assemblage represents the past 50 years with an important increase in *Thalassionema nitzschiodes,* coupled with the presence of *Actinocyclus octonarius* as a less dominant species.

Chaetoceros resting spores dominate the whole sequence, reflecting the active coastal upwelling system that overlies the sites. This group contains several morphotypes, all of which are present in the modern day upwelling coastal waters of Peru. Modern water column samples indicate high abundances of *Chaetoceros* spp. throughout the year with maxima during the summer. *Skeletonema costatum* follows a seasonal pattern with higher abundances in summer and fall. This species dominates the assemblage in eutrophic waters. Occurence of *Thalassionema frauenfeldii* generally peaks during winter. *Thalassionema nitzschiodes* is present throughout the year although with lower abundances than the aforementioned species. Although these 4 diatom assemblages characterize the Pisco and Callao cores, water column samples show a different characterization of the dominant diatom species. Species such as *Guinardia delicatula, G. striata, Leptocylindrus danicus* and *L. mediterraneus* were abundant in the water column but were not observed in the sediment cores. We hypothesize that the diatom assemblage suffers an active dissolution in the water column and on the seafloor before sedimentary burial. On the other hand, rare occurrences of freshwater diatoms were found downcore from the 25 cm level to the bottom of the Pisco core, which suggests that some valves reach the sedimentary site via pulses of riverine discharge originated in the Andes. Only a few freshwater diatom individuals were encountered in the Callao core. Total diatom concentrations are diminished in the lower half of the core (around 33 cm or 1850 AD) relative to the upper part and then decrease towards the top one. However, this decrease on diatom concentration near the core top is accompanied by a significant increase of the abundance of silicoflagellates, which may account for an important part of the paleoproductivity. The cause of the inferred increase in ocean productivity and shift in species composition in the middle of the XIX century is still unknown although it might be influenced by higher nutrient levels due to greater upwelling. Moreover, the increase of primary productivity is also supported by sustained increases in Total Organic Carbon, and preservation of calcite and benthic foraminifera by diminished oxygen levels. These combined evidences suggest a centennial-scale regime shift in the upwelling environment of the Humboldt Current off Peru

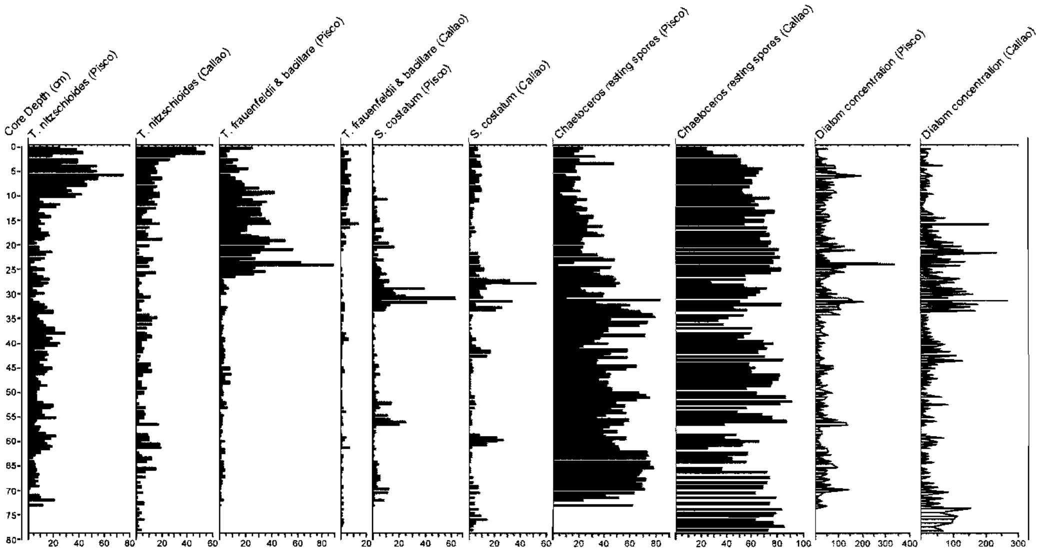

Figure 1. Temporal sequences of the dominant diatom species from downcore counts of cores B0405-6 (Pisco) and B0405-13 (Callao). Note that there are no data after the 73 cm level in the Pisco core.

HCS169 - Decadal to centennial variability of the Peruvian upwelling ecosystem during the last centuries as inferred from fish scale deposition rates of anchovy and other marine sediment records

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Introduction- The Humboldt Current System (HCS) undergoes large temporal variability at multiple time scales, which is mostly originated by climate and/or global changes. The ENSO cycle and other manifestations of climate and oceanographic interactions play a major role in both biogeochemical and ecological changes in the HCS. The length of instrumental records limits our current knowledge of the HCS variability to recent decades. Furthermore, multidecadal-to- centennial changes that have been detected in other marine systems are still largely unknown in the HCS. Fortunately, laminated sediments accumulating on the Peruvian continental margin provide paleo-archives of sufficiently high temporal resolution to resolve different modes of past climate and ecosystem changes in the HCS. In turn, revealing and understanding ecosystem changes of the system under different modes of variability can help develop scenarios of the HCS evolution for future decades, including the effects of the global change.
Because primary production and fish production can reach very high levels in the HCS, we focus our study on records of fish scale deposition from recent centuries, as a proxy of local fish biomass. In addition, we use records of total organic carbon to infer changes in primary productivity, which may be associated with fish biomass.

Methods- Four sediment cores spanning at least the past two centuries were collected at different dates from 1974 to 2004 in the upper continental margin off Callao, Peru (12°S), from water depths ranging between 179 and 305 m. Three of these cores were retrieved close to the shelf break (<190 m) within a distance of less than 3 miles (Figure 1). The cores were dated using sedimentation models derived from excess ^{210}Pb activity profiles and, in some cases, from radiocarbon analyses of organic matter. High resolution estimates of downcore fluxes of fish scales and other fish remains were calculated and compared between cores. Likewise records of total organic carbon and other sedimentological properties were also developed in some cores.

Results and Discussion- Within the twentieth century, fish scale fluxes from the different sediment cores exhibit similar patterns of variability on decadal time-scales. Anchovy and sardine scale fluxes near the core tops reflect the decline of anchovy biomass and the increase of sardine populations during the seventies and eighties, respectively. A boxcore (B0413) collected in 2004 also reflects the increase of anchovy biomass following the mid-nineties. These patterns support the use of fish scale flux as a proxy for biomass. Prior to the development of the industrial fishing activities, the highest anchovy scale fluxes are observed around the mid- twentieth century while an increase in sardine scale deposition was observed for the earlier decades of the twentieth century.
Looking backwards, the cores suggest the same multidecadal period of low fish scale deposition from the early twentieth century well into the nineteenth century, given the uncertainties associated with dating and redeposition of sediments within any given core. Observations of fissures in scales and downcore variations in the ratio of fish scales with respect to other fish remains in core B0413 suggest that dissolution of fish scales may have occurred with varying intensity through time. Nonetheless a reduction in associated fish remains that are less susceptible to dissolution (e.g. vertebrae and bones) is interpreted as reflecting an actual reduction of the flux of fish remains during much of the nineteenth century relative to other periods.
The reduction of fish scale fluxes can be attributed to lower fish biomass and/or a shift in the distribution of the population. However, total organic carbon contents in some of the cores indicate that productivity was reduced in parallel with the multidecadal period of low fish scale fluxes in most of the nineteenth century. This suggests that the ecosystem was characterized by lower primary productivity and reduced pelagic fish production, followed by a shift towards greater productivity during the twentieth century.
In conclusion, this study on past conditions of the HCS documents that, on decadal-to-centennial timescales, the Peruvian upwelling ecosystem can experience the same range in the sizes of anchovy and sardine populations as what was observed since the development of modern fisheries in the second half of the twentieth century.

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