Abstract The Humboldt Current System (HCS) is one of the most productive marine ecosystems on earth. It extends along the west coast of South America from southern Chile (~42°S) up to Ecuador and the Galapagos Islands near the equator. The general oceanography of the HCS is characterised by a predominant northward flow of surface waters of subantarctic origin and by strong upwelling of cool nutrient-rich subsurface waters of equatorial origin. Along the coast of northern and central Chile, upwelling is localised and its occurrence changes from being mostly continuous (aseasonal) in northern Chile to a more seasonal pattern in southern-central Chile. Several important upwelling centres along the Chilean coast are interspersed with long stretches of coast without or with sporadic and less intense upwelling. Large-scale climatic phenomena (El Niño Southern Oscillation, ENSO) are superimposed onto this regional pattern, which results in a high spatiotemporal heterogeneity, complicating the prediction of ecological processes along the Chilean coast. This limited predictability becomes particularly critical in light of increasing human activities during the past decades, at present mainly in the form of exploitation of renewable resources (fish, invertebrates and macroalgae). This review examines current knowledge of ecological processes in the HCS of northern and central Chile, with a particular focus on oceanographic factors and the influence of human activities, and further suggests conservation strategies for this high-priority large marine ecosystem. Along the Chilean coast, the injection of nutrients into surface waters through upwelling events results in extremely high primary production. This fuels zooplankton and fish production over extensive areas, which also supports higher trophic levels, including large populations of seabirds and marine mammals. Pelagic fisheries, typically concentrated near main upwelling centres (20–22°S, 32–34°S, 36–38°S), take an important share of the fish production, thereby affecting trophic interactions in the HCS. Interestingly, El Niño (EN) events in northern Chile do not appear to cause a dramatic decline in primary or zooplankton production but rather a shift in species composition, which affects trophic efficiency of and interactions among higher-level consumers. The low oxygen concentrations in subsurface waters of the HCS (oxygen-minimum zone, OMZ) influence predator-prey interactions in the plankton by preventing some species from migrating to deeper waters. The OMZ also has a strong effect on the bathymetric distribution of sublittoral soft-bottom communities along the Chilean coast. The few long-term studies available from sublittoral soft-bottom communities in northern and central Chile suggest that temporal dynamics in abundance and community composition are driven by interannual phenomena (EN and the extent and intensity of the OMZ) rather than by intra-annual (seasonal) patterns. Macrobenthic communities within the OMZ are often dominated in biomass by sulphide-oxidising, mat-forming bacteria. Though the contribution of these microbial communities to the total primary production of the system and their function in structuring OMZ communities is still scarcely known, they presumably play a key role, also in sustaining large populations of economically valuable crustaceans. Sublittoral hard bottoms in shallow waters are dominated by macroalgae and suspension-feeder reefs, which concentrate planktonic resources (nutrients and suspended matter) and channel them into benthic food webs. These communities persist for many years and local extinctions appear to be mainly driven by large-scale events such as EN, which causes direct mortality of benthic organisms due to lack of nutrients/food, high water temperatures, or burial under terrigenous sediments from river runoff. Historic extinctions in combination with local conditions (e.g., vicinity to upwelling centres or substratum availability) produce a heterogeneous distribution pattern of benthic communities, which is also reflected in the diffuse biogeographic limits along the coast of northern-central Chile. Studies of population connectivity suggest that species with highly mobile planktonic dispersal stages maintain relatively continuous populations throughout most of the HCS, while populations of species with limited planktonic dispersal appear to feature high genetic structure over small spatial scales. The population dynamics of most species in the HCS are further influenced by geographic variation in propagule production (apparently caused by local differences in primary production), by temporal variation in recruit supply (caused by upwelling

events, frontal systems and eddies), and topographically driven propagule retention (behind headlands, in bay systems and upwelling shadows). Adults as well as larval stages show a wide range of different physiological, ecological and reproductive adaptations. This diversity in life-history strategies in combination with the high variability in environmental conditions (currents, food availability, predation risk, environmental stress) causes strong fluctuations in stocks of both planktonic and benthic resources. At present, it remains difficult to predict many of these fluctuations, which poses particular challenges for the management of exploited resources and the conservation of biodiversity in the HCS. The high spatiotemporal variability in factors affecting ecological processes and the often-unpredictable outcome call for fine-scale monitoring of recruitment and stock dynamics. In order to translate this ecological information into sustainable use of resources, adaptive and co-participative management plans are recommended. Identification of areas with high biodiversity, source and sink regions for propagules and connectivity among local populations together with developing a systematic conservation planning, which incorporates decision support systems, are important tasks that need to be resolved in order to create an efficient network of Marine Protected Areas along the coast of northern-central Chile. Farther offshore, the continental shelf and the deep-sea trenches off the Chilean coast play an important role in biogeochemical cycles, which may be highly sensitive to climatic change. Research in this area should be intensified, for which modern research vessels are required. Biodiversity inventories must be accompanied by efforts to foster taxonomic expertise and museum collections (which should integrate morphological and molecular information). Conservation goals set for the next decade can only be achieved with the incorporation of local stakeholders and the establishment of efficient administrative structures. The dynamic system of the HCS in northern-central Chile can only be understood and managed efficiently if a fluent communication between stakeholders, administrators, scientists and politicians is guaranteed.