3.4 Discussion

The purpose of this study was to describe the composition and abundance of larval fishes and megalopal crabs that were at risk of entrainment in the new combined-cycle MBPP cooling water intake system (CWIS). The new combined-cycle MBPP is designed to reduce the existing power plant entrainment by 38 percent. Even with such a large reduction in entrainment, the remaining losses of fishes and crabs could potentially affect local populations. Previous studies of MBPP entrainment had not been required by resource or regulatory agencies, therefore these entrainment studies were designed and conducted to assess the best technology available for the new plant's CWIS design.

Entrainment studies for the new MBPP CWIS were designed to estimate the number of larval fishes and megalopal cancer crabs entrained in the CWIS over a 12-month period. Source water studies were conducted to characterize the composition and abundance of the larval fishes and cancer crab megalopae that could be entrained by the new MBPP combined-cycle CWIS. The studies demonstrated that larval gobies (i.e., unidentified gobies, shadow goby, bay goby) were the most abundant fishes (nearly 81 percent) collected at the MBPP intake station, and that brown rock crab constituted the majority (71 percent) of the megalopal cancer crabs at the intake station from January through December 2000. Larval gobies were also the most abundant taxa in source water plankton samples, and brown rock crab dominated the number of cancer crab megalopae collected in Morro and Estero bays. The entrainment and source water studies together were designed to gather information on larval and megalopal entrainment losses and potential impacts of these losses on their adult populations.

Five of the seven most abundantly entrained larval fish taxa are commonly associated with nearshore, shallow habitats, such as bays and estuaries (unidentified gobies, shadow goby, Pacific staghorn sculpin, combtooth blennies, and jacksmelt). The northern lampfish is a pelagic, midwater oceanic fish whose adult population is located in deep offshore waters from 59 to 1,980 m (193 to 6,494 ft) (Hart 1973). Thus, northern lampfish larvae transported to these coastal waters are ecologically lost to their source population. Adults of the KGB complex rockfishes collected at the MBPP intake station are more commonly found in giant kelp *Macrocystis pyrifera* forests and along rocky coastlines. The location of Morro Bay situated amidst a wide expanse of sandy beach with a few nearby kelp forests explains their low concentrations in the bay.

Three species of cancrid crab dominated the numbers of megalopae collected in Morro and Estero bays. Brown rock crab megalopae were the most numerous in both entrainment and source water plankton surveys. Their peak abundance during the spring is consistent with spawning periodicity inferred from other central California plankton surveys (Tenera 2000a, b).

While the brown rock crab is reported to spawn only once a year, the fact that they are known to occasionally produce more than one batch per year (Carroll 1982) may account for the earlier peaks in abundance. Megalopae of brown and hairy rock crab were most abundant in Estero Bay, similar to published findings of Carrasco et al. (1985) and other sources (Tenera unpubl. data) indicating offshore gradients in crab early life history stages.

The most abundant group of larval fishes collected at the MBPP intake station and present in the Morro Bay and Estero Bay source waters were larval gobiids in the family Gobiidae. These small, often cryptic fishes do not support any sport or commercial fisheries and consequently there has been little interest in studying their life history. Love (1996) suggests a role in the trophic webs of nearshore ecosystems when he notes that some gobies are common prey of cormorants and sea lions. However, since gobies often burrow into soft sediments found throughout the Morro Bay estuary, their expected abundance may play a yet undefined trophic role in the bay's ecosystem. The burrowing habits of these tiny fishes also modify the mudflat habitat, which may also play some ecological role in the bay's marine sediment community.

The abundance of larval fishes and megalopal *Cancer* spp. crabs at sampling locations in Morro Bay is strongly correlated to tide cycles. Tidal flow carries these planktonic organisms in or out of the estuary depending upon their point of origin. Some larval fish species (e.g., gobies, jacksmelt) are spawned by adult populations residing in Morro Bay and are transported into coastal waters. However, few of the larval fishes spawned in surrounding coastal waters (e.g., rockfishes, lampfish, croakers) appear in the estuary in any great abundance. Source water survey results suggested that both brown and hairy rock crab megalopae spawned in coastal waters move into Morro Bay on tidal currents. Patterns of species composition and abundance found in our study results indicated that there was a net export of larvae originating in Morro Bay to the surrounding coastal waters and little import of coastal larvae into the estuary. This finding is consistent with the fact that Morro Bay is a positive estuary for most of the year with a narrow well-defined ocean entrance. Planktonic coastal larvae could be advected into the estuary during the rainy season when two-layer flows produce counterflowing bottom currents. Hydrodynamic studies of the bay (Tetra Tech 1999) have shown that the bay's shallow geometry would limit these flows and coastal plankton to the lower end of the estuary. During late summer months of the dry season, Morro Bay becomes a negative estuary creating a greater potential for net import and transport of coastal plankton into the bay.

The general transport of fish larvae out of the Morro Bay estuary is also supported by the results of similarity analysis used to compare species composition and abundance among sampling stations. The results of comparing the survey's five sampling locations showed that Station 1 at the harbor mouth is more similar to stations within Morro Bay than to the station in Estero Bay. This result indicated that on average, fish larvae at the entrance to Morro Bay originated from the

bay and not the coastal habitat. However, this pattern of net transport certainly varied with the direction, stage, and strength of tidal flow.

3.5 Larval Clam Study

Numerous power plants along the east coast that utilize once-through cooling were queried as to how they address potential plant impacts on clam larvae. The effects of entrainment on larval clams were not an issue at any of the contacted plants except for Seabrook Station Nuclear Power Plant located in Seabrook, New Hampshire.

Bivalve larval monitoring studies were conducted at Seabrook Station to determine the impacts on soft-shell clam *Mya arenaria* larvae. *Mya arenaria* is a soft-shell clam of commercial and recreational importance along the east coast. There was concern that larval entrainment had the potential to affect the benthic life stages of the soft-shell clam, thereby affecting the species population in Hampton Harbor. It was determined, using nine years of monitoring data, that there was no evidence that the operation of Seabrook Station affected the abundance of any of the life stages of the soft-shell clam (Normadeau 1999).

Plankton sampling targeting the collection of larval clams began in Morro Bay in March 2001 and will continue through September 2001. Detailed collection and processing methodologies are discussed in Appendix D. The time period selected for sample collection brackets the major spawning season of most benthic invertebrates and employs an adaptive sampling strategy designed to capture pulses of bivalve recruitment. The targeted species are major prey items for sea otters: the Washington clam, *Saxidomus nuttali*, gaper clam, *Tresus nutalli* and Pismo clam, *Tivela stultorum*. Two other species, *Macoma secta* and *Mytilus galloprovincialis* (also sea otter prey), are likely to be particularly abundant in samples and are also targeted. A strategy for identifying and enumerating larvae that are not among these targeted species, but may be abundant in the samples, was also proposed. Existing sequence detection methods (exonuclease cleavage of reporter dyes from specific probes, also known as Taqman® assay) will be used.

Sampling sites and schedule are the same as for entrainment and source water studies described in Section 3.2, except a weekly sample will be taken to detect the onset of recruitment pulses. Larval density data, in conjunction with plankton sample, entrainment and source water volume estimates, will be used to estimate proportional losses due to entrainment for these clam species during the sampling period.

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