Characterization of fish assemblages within San Francisco Bay: implications for biological monitoring strategies and design of habitat restoration projects.

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ABSTRACT

The U.S. Fish & Wildlife Service, Stockton, California, juvenile fish monitoring program (JFMP) is a participant in the Interagency Ecological Program (IEP) and under the auspices of IEP has voluntarily collected data on fish assemblages at key sites in the San Francisco Bay area since 1999. JFMP sites include Keller Beach, China Camp, McNear’s Beach, Pt. Pinole Beach, and San Francisco Bay, Emeryville, Delta, and Sacramento and San Joaquin rivers. For the last twenty years, the JFMP has collected data on fish species abundance, diversity, similarity, stability, and persistence that were examined between 1999 and 2005 at the JFMP site. All methods and protocols were standardized for each site using Programs for Ecological Monitoring software (Krebs 2003). Results of Persistence were evaluated in Microsoft Excel.

DISCUSSION

The U.S. Fish & Wildlife Service, Stockton, California, juvenile fish monitoring program (JFMP) is a partner in the Interagency Ecological Program (IEP) and under the auspices of IEP has voluntarily collected data on fish assemblages at key sites in the San Francisco Bay area since 1999. JFMP sites include Keller Beach, China Camp, McNear’s Beach, Pt. Pinole Beach, and San Francisco Bay, Emeryville, Delta, and Sacramento and San Joaquin rivers. For the last twenty years, the JFMP has collected data on fish species abundance, diversity, similarity, stability, and persistence that were examined between 1999 and 2005 at the JFMP site. All methods and protocols were standardized for each site using Programs for Ecological Monitoring software (Krebs 2003). Results of Persistence were evaluated in Microsoft Excel.

METHODS & RESULTS

All sites were sampled biannually following JFMP standard sampling procedures (Krebs 2003). Species lists were assembled through queries of the JFMP historical database and were limited to the site name list from sample years 1999-2005. Fish not identified to species were excluded. JFMP sampling gear is targeted towards juvenile and small adult fish, therefore, accidentally captured large fish species (i.e., leopard shark) were excluded from the analysis. Since overall assemblage structure is generally targeted for information we chose assemblage metrics that allow for interpretable sampling (i.e., changes in species composition) rather than changes in absolute abundance (i.e., in-organism metrics). To characterize the JFMP we excluded the following metrics: species richness, total number species, total number of individuals, and number of species per sample. These metrics are expanded below in the corresponding graphs and results. All diversity calculations and Morisita’s index were completed using Programs for Ecological Monitoring software (Krebs 2003). Results of Persistence were evaluated in Microsoft Excel.

SPECIES RICHNESS

Species Richness for JFMP within a site (Fig. 2). Species richness (r) was calculated for Keller Beach (1999-2005). The mean species richness for Keller Beach was 17.6 species with a range of 12-22 species. Species richness was calculated for Keller Beach for the years 1999-2005. Species richness in Keller Beach ranged from 12 to 22 species (x = 17.6) between 1999 and 2005. Keller Beach was the site with the highest species richness.

DIVERSITY

Diversity was measured using Simpson’s Index which ranges from 0 (low diversity) to 1 (high diversity) and is sensitive to changes among the more abundant species (Krebs, 2002). Total diversity for JFMP sites (Fig. 4) was not to species richness (r) (r = 0.73). Maximum diversity for any single site was at Tiburon Treasure in 2003 (r = 0.73) while minimum diversity was 0.70 at Tiburon in 2004. Mean diversity at individual sites between 1999 and 2005 was low to moderate, with China Camp, McNear’s Beach, Pt. Pinole, and Tiburon Treasure exhibiting the greatest diversity. Diversity was measured using Simpson’s Index (0.61), McNear’s Beach (0.60), and Pt. Pinole (0.64) (Fig. 7). Diversity values were not significantly different among the sites.

STABILITY

Stability was measured using Kendall’s Coefficient of Concordance (Kendall’s Coefficient of Concordance, corrected for ties) (Krebs, 2002). Stability values were calculated for JFMP sites (Fig. 5). Stability values ranged from 0.49 to 0.65 with Keller Beach having the greatest stability (0.65) while Paradise Beach had the lowest stability (0.49). Stability values were not significantly different among the sites.

PERFORMANCE

Preliminary results for JFMP sites (Fig. 6) were calculated using Programs for Ecological Monitoring software (Krebs, 2003). Preliminary results were calculated for Keller Beach, China Camp, McNear’s Beach, Pt. Pinole, and Tiburon Treasure. Preliminary results for Keller Beach were calculated for the years 1999-2005. Preliminary results for Keller Beach were calculated for the years 1999-2005. Preliminary results for Keller Beach were calculated for the years 1999-2005. Preliminary results for Keller Beach were calculated for the years 1999-2005. Preliminary results for Keller Beach were calculated for the years 1999-2005.

REFERENCES

Block et al. (2001). Natural communities are assumed to be internally stable stable over time, and diversity of species is measured by the stability of the assemblage (Krebs 1999). Stability values were calculated for JFMP sites (Fig. 5). Stability values ranged from 0.49 to 0.65 with Keller Beach having the greatest stability (0.65) while Paradise Beach had the lowest stability (0.49). Stability values were not significantly different among the sites.

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Figure 1. San Francisco Bay area with JFMP sites. Map courtesy of Larry R. Brown, USGS.

Figure 2. Total annual (1999 – 2005) species richness at JFMP sites.

Figure 3. Mean species richness (1999 – 2005) at JFMP sites.

Figure 4. Total annual (1999 – 2005) diversity at JFMP sites.

Figure 5. Mean annual (1999 – 2005) diversity at JFMP sites.

Figure 6. Preliminary performance of JFMP sites at Keller Beach.

Figure 7. Seasonal algae at Keller Beach.