5. Data Dissemination

5.1 FTP

The data analyses and maps completed by the Status and Trends project will be made available to GBEP partner organizations and the public through a file transfer protocol (FTP) site located at ftp://trendstat.eih.cl.uh.edu/. Data are organized by major category: water quality, sediment quality, fisheries resources, colonial nesting birds, freshwater inflows, oil spills and seafood safety.

Annual trend graphs and their associated data tables are available for water and sediment quality and fisheries resources. Monthly and seasonal trends will be available at the time of the final report. Requests can be made to the Status and Trends project for specific analyses or data not currently incorporated on the FTP site.

5.2 Web Query Format

The Status and Trends project worked with researchers at the University of Houston-Clear Lake to design a demonstration model of a web queriable Status and Trends database format. Dr. Mohammad Rob and Laurie Hubenak of the University of Houston-Clear Lake completed the demonstration web site, which will be available through a link on the GBEP and EIH websites.

Users will be able to query summary data (annual averages and annual CPUEs) within the database by Galveston Bay sub-bay or tributary through a clickable map interface. For example if the user is interested in fisheries data, they will be able to acquire that data for a particular sub-bay, gear type and species.

It is the hope of the Status and Trends team that with the guidance of the GBEP and its subcommittees, this demonstration model will be expanded in the next phase of the project so that users will be able to access the data through web query as an alternate to FTP download of the data.

6. Discussion

6.1. Relationships Between Parameters and Data sets

The discussions above highlight the many changes that have occurred in Galveston Bay over the periods of record covered by the data sets included in this study. The correlation analyses appended to the description of single parameter trends demonstrate the complexity of the systems these variables describe. A simple system would involve few processes and many measurements of the attributes of the system would be correlated. Obviously Galveston Bay is a complex set of systems involving many processes that are interlinked, but independent to some degree. This is apparent when two parameters of water quality, e.g. ammonia and fecal coliforms, are correlated in West Bay, but not in Trinity Bay.

Components of the Galveston Bay system that are theoretically dependent often do not show correlation. This is demonstrated for a variety of parameters. High phytoplankton concentrations should be associated with low dissolved oxygen (DO) at dawn, but there is no correlation between morning values of chlorophyll-a and DO. There is no correlation between low trophic level fishes and chlorophyll-a, which should be an indicator of primary productivity in the water column. There are few significant correlations between species that are usually described in predator-prey relationships, such as red drum and blue crab.

There are enough correlations that fit the accepted model of ecological processes in Galveston Bay to maintain the paradigm of ecosystem organization described by McFarlane (1994) and others. The multivariate analyses suggest that nutrients are important drivers of the biological systems, but the relationships change across the geography of the Bay. Trinity Bay is dominated by freshwater inflow from the Trinity River and responds to the nutrient loadings from the river. Upper and Lower Galveston Bay is dominated by the inflows from urban and industrial treatment facilities and run-off through tributaries that drain the urban complex. West Bay receives less freshwater inflow and is dominated by local Bay and perimeter systems. Indicators that serve as useful descriptors of the health of ecosystems in one sub-bay may not be adequate descriptors of another.

Despite the large quantity of effluent received by Galveston Bay and its tributaries, it is still a biological system that operates on ecological principles. There are contaminants that enter the Bay, but not enough to disrupt the ecosystems. There are no trends that suggest living systems are being overwhelmed by pollution. There are trends that suggest anthropogenic impacts may be harming the Bay and its associated ecosystems, but the ecological processes are still functioning as expected.

6.2. Identification of Potential Indicators

Many parameters in the TCEQ data set directly measure contaminants, i.e. metals, organics and synthetic compounds. Most of these parameters are measured infrequently from few locations that are not representative of the Bay as a whole. A few of them could be used as indicators of the suite of contaminants with concomitant savings of effort in monitoring.

While mercury is of great concern because it is highly toxic in small amounts, it is not the most promising indicator of metal contamination in Galveston Bay. Mercury is only found in measurable concentrations in sediments in a few locations, particularly the Houston Ship Channel. Cadmium is found in more locations in sediment and water. Interestingly, cadmium concentrations in water show an increasing trend while cadmium concentrations in sediments show a decreasing trend. There are measurable concentrations of cadmium in many samples of seafood assessed in the TDH study of seafood safety. Concentrations of this metal in seafood are correlated to the concentrations of copper and zinc. So monitoring cadmium in multiple media from more locations more often will provide a more coherent picture of the impact of metals on the health of Galveston Bay than measuring more metals from fewer samples.

In addition to metals, there are toxicants entering Galveston Bay as results of common human activities. A variety of organic solvents are found in the Bay, but the databases do not document cause for concern outside the Ship Channels and areas next to industry. Of more general concern, because they derive from widespread agricultural and lawn care activities, are pesticides and herbicides. Most of the measurements in the data sets are of pesticides rather than herbicides, so any indicator of trends must be selected from this group. There are two legacy pesticides that continue to be detected in concentrations sufficiently high to indicate continued input. The parameters that could be used at this time as indicators of pesticide contamination are chlordane and the suite of DDT and its breakdown products, DDE and DDD. Perhaps these legacy pollutants will become less useful as indicators as the time since their banning increases, but at this time they best illustrate the picture of pesticide contamination across the Bay.

In industrial areas, dioxins should be measured in sediment despite the localized nature of their detection. These industrial by-products are different from the metals and pesticides in their origin and distribution. So concentration of dioxins in sediments is an indicator of a third type of pollution that would have a different fate and set of transport mechanisms.

Multiple, distinct indicators ensure better understanding of chemical and biological processes associated with the Bay system and their contaminants. One set of indicators that is directly applicable to assessing the health of the Bay and its users is seafood contamination. The TDH data set is voluminous because so many potential chemical contaminants are assayed. While this may be necessary for a thorough assessment of seafood safety, it is not desirable for monitoring. A much smaller set of parameters could be used to indicate the presence of undesirable chemicals in seafood. Those metals of most concern are mercury and cadmium. Mercury appears to be declining in the Houston

Ship Channel, but its history as a seafood safety issue would justify its measurement. Cadmium as noted above shows an increasing trend in water and is detected often in fish flesh and blue crab bodies. Seafood should also be tested for residues of pesticides, in particular chlordane, which was found to be high in the Houston Ship Channel and nearby small bays. Other pesticides that are worthy of consideration as indicators of all pesticide loading are DDT, DDE, DDD, aldrin and dieldrin. Organic contaminants that could be used as indicators of contamination from commercial processes are benzene, toluene and PCBs. These contaminants are detected in sediment samples and seafood tissue samples.

The foundations of the ecosystems in Galveston Bay are reflected in the nutrient concentration monitored as water quality parameters. Total phosphorus appears to be a good indicator of many aspects of the ecosystems in open bay waters. One of the reasons that nitrate and nitrite do not have significant relationships with living resources may be the variety of loadings providing nitrogen compounds to the Bay. The Houston region has a high concentration of nitrogen oxides in the air during nearly all of the year. A large amount of the nitrogen entering the Bay may come from air deposition, but it has not been adequately measured in the Houston area. Nitrogen compounds are typically more concentrated in fertilizers, which enter the Bay in stormwater runoff and river inflows. Phosphorus shows the widest set of correlations to chlorophyll-a and other nutrients as well as TSS and TOC in some sub-bays. In addition, total phosphorus exhibits correlations to two bird species and at least one fish species. Ammonia exhibits correlations under conditions that would support a detritus-based food chain.

Indicators of the health of living resources in the Bay could be obtained from the data base provided by TPWD Coastal Fisheries monitoring efforts or the Colonial Nesting Bird data base provided by USFWS. The correlation analysis of bag seine, shrimp trawl and gill net CPUEs for selected species showed a variety of relationships. The significant relationships changed across the major sub-bays. Despite the variation some consistency is present. Only a few species are present in the catch of all three common gear types. Of those, Atlantic croaker appears to be correlated to the greatest number of other species. Sand seatrout and Southern flounder show a high number of relationships and are captured in multiple gear types. (Sand seatrout was not used in this analysis of gill net catches, but is represented in the catch.) Another predator that would be of interest as an indicator is the spotted seatrout because it demonstrated a relationship with nutrient concentrations and chlorophyll-a.

Among lower trophic level fishes, several species could be used as indicators. The analyses of bag seine data used five such species and three species were included in the analysis of correlations with chlorophyll-a trends. Two species stand out because they exhibit numerous correlations with water quality parameters and with higher trophic level fishes and birds. These are Gulf menhaden and striped mullet. Both are captured in bag seines and shrimp trawls. Striped mullet are also commonly reported in gill net catches. Both species appear to represent important links in the ecosystems of the Bay.

The Colonial Nesting Bird survey provides a unique perspective on biological systems because the numbers are not reflective of the current abundance of the bird species, but of their efforts to reproduce. A downward trend in effort to reproduce should be reflected in abundance at some future time, but the life expectancy of many species is sufficient to delay the response by a decade. A set of indicators obtained from the water bird data should reflect the different feeding guilds: open water and marsh edge, as well as different trends. The number of royal tern nesting pairs shows a correlation to the sandwich tern numbers and to some fish species abundances. It belongs to the open water feeding guild and has an increasing trend. The black skimmer is correlated to the least tern in many cases and to some nutrient concentrations and other water quality parameters. It has a feeding strategy that combines open water feeding and marsh edge. The tricolored heron is the most numerous of the water bird species nesting around Galveston Bay, but it has a declining trend. It belongs to the marsh edge feeding guild. Snowy egret shows correlations to other marsh edge feeders and has a stable trend of nesting pairs. Getting better data on abundance or reproductive success of these four species would be valuable to our understanding of the dynamics of all water bird species using Galveston Bay.

Of course, other observers would see value in many other parameters and species as indicators of the health of Galveston Bay. These choices reflect the relationships and trends that attracted our interest. Far more analysis is needed before all of the relationships embedded in these data sets can be described. Then the analyst must fit the relationships and trends into an explanatory model. The strength of the relationships in a logical model could justify a condensed set of indicator variables that could be used to safely monitor the health of Galveston Bay. In the absence of a simplified model, our understanding of Galveston Bay is dependent upon gathering data for most of the existing parameters measured from more samples at more locations.

7. References

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