

**Briefing Paper on Galveston Bay Plan Action Items
Public Health**

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Overview

Goals of the Galveston Bay Plan

- Reduce potential health risk resulting from consumption of seafood contaminated with toxic substances
- Reduce oyster reef harvest closures
- Minimize risk of waterborne illness resulting from contact recreation

The role of public agencies in protecting the public from health hazards associated with the bay falls into two categories. The Galveston Bay Plan incorporates in its goals the need for reducing the risk of illness (a) from the consumption of seafood harvested from the bay or its tributaries and (b) from contact with or ingestion of the water in the bay and its tributaries. The Texas Department of State Health Services (DSHS) (formerly known as the Texas Department of Health) tracks illnesses associated with consumption of contaminated seafood and operates monitoring programs designed to alert the public to potential risks and to manage exposure to contaminated seafood.

The risk of illness from contaminated seafood is low, but there are occasional outbreaks of infectious diseases, particularly due to several types of bacteria in the *Vibrio* group. *Vibrio vulnificus* is a naturally occurring bacterium that can be contracted from consumption of oysters or from contact between Bay water and an open wound. It can be fatal to sensitive individuals, especially those with damaged livers or compromised immune systems. In 1998 more than 400 people became ill during an outbreak of a related bacteria, *Vibrio parahaemolyticus*, contracted from consumption of oysters. The bacterial strain was one previously found only in East Asia. It was likely discharged in Galveston Bay from a ship transporting goods from Asia. Galveston Bay has the potential to host other pathogenic bacterial strains, e.g. *Vibrio cholera*, and viruses, e.g. polio and hepatitis. Consumption of raw oysters is a potential pathway for these organisms to infect humans because thorough cooking destroys the infective agents.

Another form of risk from consumption of seafood is the content of hazardous chemicals in the flesh of fish and shellfish. The DSHS monitors the contamination of fish and crabs in the Galveston Bay system with the support of the Galveston Bay Estuary Program. Many compounds are tested, but they can be summarized in two ways: chemical nature and health effect. DSHS tests samples for toxic metals, pesticides, volatile and semi-volatile organic compounds. Most of the organic compounds are tested because they are believed to carry a risk of increased probability of cancer development. Metals, pesticides and some organics are monitored because they can damage a variety of organ systems.

Illness or death from exposure via contact to water of the bay system is very rare, but could occur in some areas. TCEQ and several local agencies monitor the water and sediment quality at multiple locations in the bay system. Monitoring has shown that several of the tributaries have potentially harmful levels of contamination by fecal coliforms; bacteria that normally reside in the intestinal tracts of mammals and birds. They serve as indicators of possible sewage pollution. Sewage contamination is often associated with storm events when rainfall causes sewage treatment plants and collection systems to overflow or sewage from underground septic systems to percolate to the surface. When severe flooding results in the inundation of houses, many people have contact with water that is contaminated with pathogens and chemical pollutants.

Historical Data Trends

There are several ways to look at the historical patterns of the relationship between human health and Galveston Bay. Prior to the advent of water purification plants for drinking water, there were frequent outbreaks of waterborne diseases in the Galveston Bay watershed. Today if drinking water is obtained from a municipal system it has been treated to minimize the likelihood of infectious organisms and monitored for chemical pollutants. On the other hand, seafood harvested from the bay more than 100 years ago was rarely a risk if consumed soon after harvest. The risk from consuming seafood from the bay that is contaminated with microorganisms appears to have increased. Certainly the risk of consuming seafood contaminated with pesticides or toxic chemicals has increased over the last 100 years.

The record of monitoring for public health reasons goes back to the 1950's. Over the period of record, fecal coliform contamination has increased in some tributaries and has been quite variable in the various sub-bays. It is difficult to obtain a historical pattern from the monitoring data on contamination of seafood with metals and organic chemicals. One problem is a bias in the sampling. There is no random monitoring. Sampling sites are located in areas that are most likely to have contamination problems.

Status in the Lower Galveston Bay Watershed

Chemical Contamination of Seafood

The DSHS conducted a series of health consultations for the Galveston Bay system in the years 1998 through 2000. Muscle tissue of adult fish and composite samples of blue crab captured by gill net at various locations were tested for multiple contaminants. Contaminant concentrations were analyzed by the DSHS using standard methodologies. Measured concentrations for each of the tested compounds were compared to a health assessment value obtained from publications of DSHS. Health-based assessment comparison (HAC) values are used by the DSHS to issue seafood consumption advisories. HACs set a conservative limit for safe seafood consumption because they assume frequent consumption of substantial servings.

The Galveston Bay Indicators Project calculated risk ratios based on a comparison of average concentrations of selected contaminants to their respective HAC values. A risk ratio equal to one meant that the average concentration of a contaminant was equal to the value at which DSHS considers issuing a seafood consumption advisory. The indicator's rating system suggests that risk increases as the concentration of contaminants detected in the seafood increases. It does not recognize a threshold effect in terms of risk from consumption. However, the relationship between concentration of contaminants and safety of seafood consumption is not simple and may involve thresholds for health effects. This scoring method is a simple way to compile the results over multiple compounds. The DSHS remains the primary source for advisories of seafood consumption.


The compounds depicted in Table 1 represent a range of potential health impacts. The various compounds and metals are known or suspected to cause acute or chronic diseases of the nervous, circulatory, endocrine and other systems of the body. The compounds have the potential to be more damaging in combination than alone, but very little research has been done on synergistic effects of pollutants.

Risk from metal contamination is based on data collected for cadmium, mercury, and zinc. While other metals were detected, cadmium, mercury, and zinc have been extensively evaluated for health impacts and HACs are readily available.

Pesticides selected for inclusion in the indicator were chlordane, DDE, dieldrin, heptachlor epoxide and hexachlorobenzene. These compounds are the most commonly detected pesticide contaminants in the DSHS data. Inclusion of more pesticides in the calculation of the indicator would not significantly change the risk level or the relationship among locations in the bay. The risk indicator for PCB contamination of Galveston Bay seafood is calculated using the HAC value for all PCBs and based on tissue concentrations of a single compound, Aroclor 1260.

Locations	Metals	PCB	Pesticides	Dioxin
Houston Ship Channel	Green	Red	Yellow	*
Upper Galveston Bay	Blue	Green	Blue	*
Lower Galveston Bay	Blue	Blue	Blue	**
Clear Lake	Blue	Green	Blue	**
Trinity Bay	Blue	Yellow	Blue	**
East Bay	Blue	Blue	Blue	**
West Bay	Green	Blue	Blue	**
Christmas and Bastrop Bays	Yellow	Blue	Blue	**

Rating



Very Good
Good
Moderate
Poor

The indicator is based on data collected by the DSHS in 1998-2000
 *Rating based on existence of a Seafood Consumption Advisory
 ** Insufficient data

Table 1. Rating of risk from consumption of contaminants in fish captured in various parts of the Galveston Bay system. Table created by the Galveston Bay Indicators Project. Data source: Texas Department of State Health Services.

Bacterial Contamination of Water

Fecal coliform bacteria are monitored as an indication of the probability of the presence of human pathogens. Unfortunately, other mammals and birds excrete bacteria that are detected by this test. Therefore, sources of fecal coliform bacteria are difficult to determine. Concentrations of fecal coliforms are monitored by the TCEQ for assessment of water quality.

Monitoring records were separated into subbay and tributary depending on the type of water body from which samples were collected. The percentage of samples exceeding the TCEQ screening level for fecal coliform bacteria (400 colonies per 100 mL) was calculated by decade for selected subbays and tributaries. The percentage of samples exceeding the screening level in each subbay and tributary was then evaluated according to a rating system established by the Galveston Bay Indicators Project (see Table 2).

As seen in the Table below, the subbays of Galveston Bay rate “good” with nine percent or less of the samples exceeding the fecal coliform bacteria screening level. For the years 2000-2003, four areas rated “poor” for fecal coliform bacteria: Buffalo Bayou, the Houston Ship Channel, Clear Creek, and Dickinson Bay/Bayou. The San Jacinto River, Armand Bayou and Bastrop Bay rated “moderate”.

SUBBAYS		1970s	1980s	1990s	2000s
Upper and Lower Galveston Bay		Green	Green	Green	Green
Trinity Bay		Green	Green	Green	Green
East Bay		Green	Blue	Green	Green
West Bay		Blue	Green	Green	Green
Christmas Bay		Green	Green	Green	Green
TRIBUTARIES		1970s	1980s	1990s	2000s
Trinity River		Yellow	Green	Green	Green
San Jacinto River		Yellow	Yellow	Yellow	Yellow
Buffalo Bayou		Red	Red	Red	Red
Houston Ship Channel		Red	Red	Red	Red
Clear Creek/Lake		Red	Yellow	Red	Red
Armand Bayou		Red	Red	Red	Yellow
Dickinson Bayou/Bay		Yellow	Yellow	Yellow	Red
Chocolate Bayou/Bay		Yellow	Yellow	Yellow	Green
Bastrop Bayou		Red	Yellow	Yellow	Green

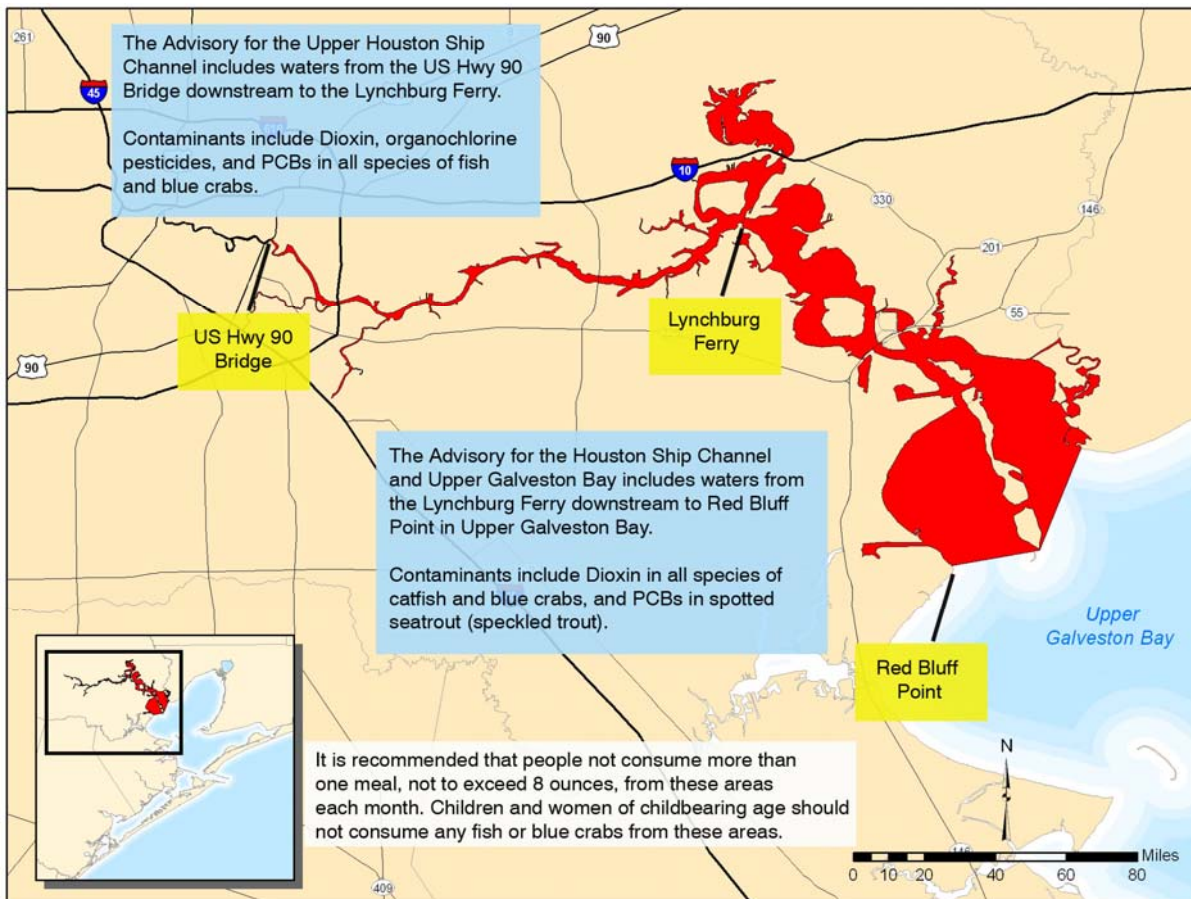
Rating	% Above Screening Level
Very Good	0
Good	1-9
Moderate	10-25
Poor	>25

Table 2. Rating of water quality with regards to fecal coliform bacteria in the major subbays and tributaries of Galveston Bay over the last four decades. Table created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Commission on Environmental Quality.

Seafood Consumption Advisories

Three seafood consumption advisories for Galveston Bay and its tributaries have been issued by the DSHS since 1990. While the majority of bay and tributary surface waters are not included in seafood consumption advisories, the DSHS advises that consumption of seafood taken from the Houston Ship Channel and portions of Upper Galveston Bay poses an increased risk of adverse human health effects. All three seafood consumption advisories in 1990, 2001, and 2005 were issued for these areas (Figure 1). Contaminants of concern include dioxin, organochlorine pesticides, and PCBs (Polychlorinated Biphenyl: a synthetic, organic chemical once widely used in electrical equipment). Species of concern include blue crab, catfish, spotted seatrout, and other species of finfish.

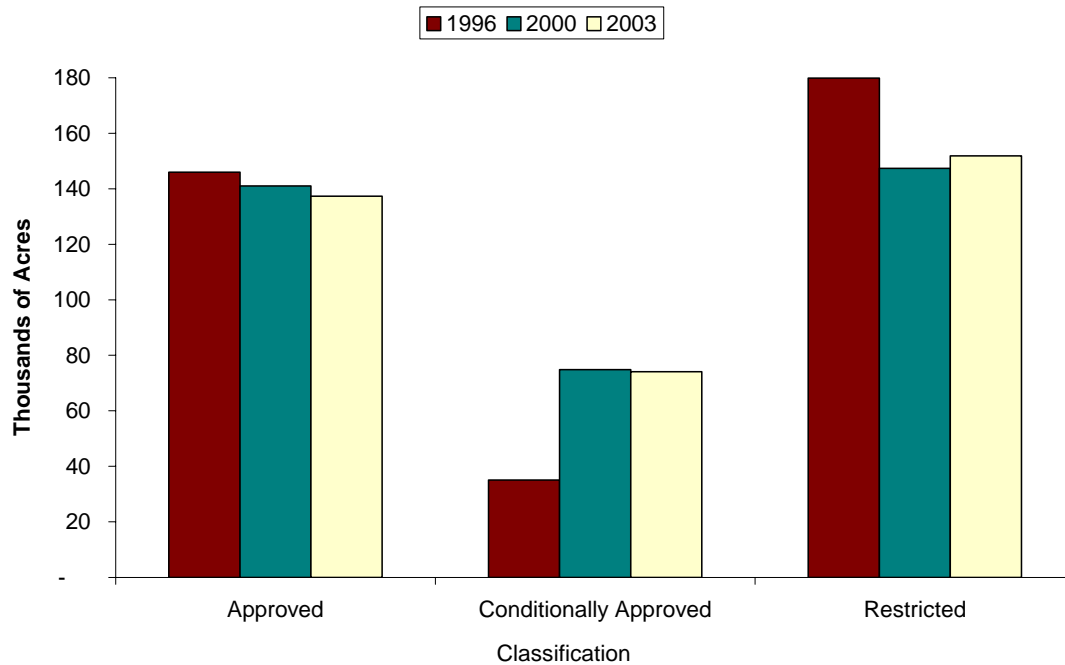
Figure 1. Description of the Area, Species, and Contaminants Included in Galveston Bay Seafood Advisories Issued by the Texas Department of State Health Services in 1990, 2001, and 2005. Map created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Department of State Health Services.



Bacterial Concentrations in Shellfish Waters

Harvest of shellfish is regulated according to the likelihood that shellfish will be contaminated with human pathogens. The determination of how to classify an area is made based on the record of monitoring for fecal coliforms. Shellfish harvest areas are classified as approved, conditionally approved, restricted or prohibited. DSHS reviews the classification periodically and issues new classifications. Recent classification of shellfish waters in 1996, 2000 and 2003 were compared in Figure 2. Surface water acreages were calculated for each category in each year selected and are shown for the classifications approved, conditionally approved and restricted in the chart below. Prohibited areas are very unlikely to change. So that category was omitted. Figure 2 shows that there has been a decrease in the acres of water that are restricted for shellfish harvest.

Figure 2. Comparison of DSHS Approved, Conditionally Approved, and Restricted Shellfish Harvest Areas in Galveston Bay for the Years 1996, 2000, and 2003. Figure created by the Galveston Bay Indicators Project, Houston Advanced Research Center. Data source: Texas Department of State Health Services.



Regulatory Management Efforts

Permitting

The most effective regulatory tool for reducing water pollution is the permitting system known as the National Pollutant Discharge Elimination System (NPDES). Under this system sewage treatment plants are permitted to discharge treated water with a specified low level of fecal coliform bacteria. This level is set to maintain the historical water quality of the water body. This regulatory system is clearly failing to prevent increased levels of coliform bacteria in several tributaries of Galveston Bay. There is a debate about whether the increases observed in coliform bacteria actually represent increases in human pathogens.

DSHS has regulatory authority over the harvest of shellfish by commercial oyster fishermen. They are empowered to prevent the entry of Galveston oysters into the commercial market. This regulatory system appears to be relatively effective, but can not prevent all illnesses from contaminated shellfish. In the summer of 2000, the oyster fishery was closed due to contamination by toxic chemicals produced by red tide algae. There are no reported cases of poisoning from this event. However, in 1998 hundreds of people became ill from Galveston Bay oysters contaminated with *V. parahaemolyticus* before the fishery was closed. This regulatory system is operated conservatively and is effective in keeping seafood borne illness at a low level.

Using measurements of coliform bacteria to regulate the harvest of oysters can not prevent occasional illness from naturally occurring *V. vulnificus*. A research program has been initiated to develop methods to predict contamination of oysters by this organism.

Houses constructed near the bay in areas not served by sewage systems have relied on site treatment using buried septic tanks with drain fields. These systems are often ineffective because the soils are poorly drained and usually percolate to the surface and run into the bay after heavy rainfall. Regulations on the installation of such systems have become stricter. Efforts are being made to replace these systems with centralized sewage treatment systems. Despite these efforts, septic systems are contributing to the bacterial contamination of the bay and its tributaries.

Nonregulatory Management Efforts

Seafood Consumption Advisories

There is no legal power associated with a seafood consumption advisory. People can ignore the advisory and harvest and consume contaminated seafood. This approach to protecting public health requires education and communication. Signage is erected where possible and announcements are made. Despite efforts few people, even those who fish in these areas, are aware of the advisory about consumption of seafood harvested in this area. A large portion of the Galveston Bay area covered by seafood advisories is in heavily industrialized areas. Fortunately, most people associate water near these facilities with unhealthy conditions and will not fish there.

Marina Pump-out facilities

Some of the contamination of Galveston Bay waters with fecal bacteria is the result of sewage discharge from recreational boats. A program has been developed to encourage boat owners to employ pump out facilities at the marina rather than dumping the waste in the bay. This service is not available at all marinas and is not used by all boat owners even where it is available.

Water Treatment Enhancement Efforts

A great need exists for new or repaired sewage treatment facilities. Federal program exist to provide grants and loans for constructing new treatment facilities or improving existing facilities. The need is greater than the available resources. GBEP is providing educational and training support to operators of small sewage treatment facilities which are the source of most permit violations in the watershed. Better incentives for repair and replacement of old treatment plants and more training for operators of small facilities would likely lead to significant reductions in the concentrations of fecal coliform bacteria in the waters of the Galveston bay system.

Conclusion

The level of fecal coliform contamination in many urban tributaries of Galveston Bay is too high to meet the standards set for protection of contact recreation. It is not clear that all of the bacteria contributing to the contamination are from human sources, but concentration in several areas has risen as the density of residential development has increased. Contact recreation (i.e. swimming) in several of the tributaries of the bay would be ill advised. Large areas of the bay are restricted for shellfish harvest due to concern that the level of fecal coliform bacteria in the water could result in illness of consumers of raw oysters. Management efforts to protect public health by keeping the level of coliform bacteria low have been unsuccessful. Although strict regulation will be needed to prevent human illness, greater resources for repair and replacement of sewage treatment facilities will be the most effective method for reducing this type of pollution.

An advisory against consumption of seafood from the Ship Channel and connected segments of the bay is in place. Monitoring of chemical contamination of seafood is a recent phenomenon. The more monitoring studies are performed, the more contamination has been found. DSHS is very conservative in issuing advisories at levels of contamination that would probably result in health effects only after substantial consumption over a long time. There is no evidence that anyone has become ill from consumption of fish or shellfish from Galveston Bay as a result of chemical contamination. Management efforts to improve water quality should result in lower levels of seafood contamination. However, some of the most significant contamination is due to legacy chemicals that have not been legal for sale for a decade or more. More work is needed to understand the pathways over which these chemicals are reaching the seafood. GBEP is making a major contribution by supporting studies of seafood contamination.