

Public Health Issues in the Gulf of Mexico

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U.S. Environmental Protection Agency
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PUBLIC HEALTH ISSUES IN THE GULF OF MEXICO

Proceedings of a Mississippi Sea Grant
Advisory Service Workshop
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INTRODUCTION

The Environmental Protection Agency's Gulf of Mexico Program was established to provide a mechanism for addressing complex environmental problems in the Gulf of Mexico that cross state, federal, and international jurisdictional lines. Many of these problems and issues are unique to the Gulf.

During the early stages of Program development the Policy Review Board, at the recommendation of the Technical Steering Committee, established eight technical subcommittees co-chaired by federal and state representatives. The Public Health Subcommittee, co-chaired by Dr. Fred Kopfler, EPA Gulf of Mexico Program and Mr. Richard Thompson, Texas Department of Health is one of the eight originally established subcommittees.

The Public Health Subcommittee met in March, 1989 and, after discussing environmental factors that could have an adverse affect on public health, developed lists of agents of public health concern and various potential routes for human exposure. Two classes of pathogens were identified; those that occur naturally in the estuarine environment and those that originate from fecal contamination. Toxic chemicals were classified as organic and inorganic compounds.

The subcommittee then decided upon and ranked perceived problems concerning public health in the Gulf of Mexico. They are, in descending order: 1) exposure to human pathogens via consumption of raw molluscan shellfish; 2) marine biotoxins (such as ciguatoxic fish poisoning) and their affect on human health; 3) toxics (such as mercury) in the food chain, the potential for biomagnification and human health effects caused by consumption; and 4) human pathogens transmitted by direct contact via recreation and/or occupation. The subcommittee also concurred that risk analysis and communication were important components in all aspects of public health concern.

This framework served as a model for the development of the Public Health Issues Workshop. A subcommittee meeting was held on July 27, 1989 for planning purposes. During the course of this meeting the group consensus was that a two-day program was required which would involve concurrent work sessions and bring together experts in the various subject matter fields from all areas surrounding the Gulf of Mexico. Mississippi State University through the Sea Grant Marine Advisory Services/ Mississippi Cooperative Extension Service was charged with identifying the proper workshop participants and arranging for a suitable meeting site. Although four subject matter areas were previously identified, only three were addressed at the workshop. It was felt that the toxics in the food chain issue was complex enough to warrant a separate meeting devoted solely to that topic. The work sessions which were convened were composed of a molluscan shellfish

workgroup, a direct contact workgroup, and a marine biotoxins workgroup. A member of each of these panels was chosen to serve as facilitator/rapporteur.

PATHOGEN EXPOSURE VIA MOLLUSCAN SHELLFISH

Introduction

The health problem in molluscan shellfish really hasn't changed since 1925, i.e., people get sick as a result of eating raw molluscan shellfish. The three options available in 1925 are still the same options today. First, one might outlaw the sale and consumption of raw molluscan shellfish. But that is harmful to an industry which affects economic bases of coastal communities. That was tried with the prohibition of alcohol and it didn't work. The second option is to do nothing. With this approach, people continue to get sick in increasing numbers. So that is really not effective. A compromise must be reached somewhere in between. And that of course is the goal of the National Shellfish Sanitation Program (NSSP) and the Interstate Shellfish Sanitation Conference (ISSC) which brings us to the third option.

Shellfish management agencies provide as much protection as possible, recognizing the fact that they are dealing with something that is socially acceptable to be eaten raw, and is going to cause a certain amount of illness no matter what they do. And that is a paradox. This creates a real problem. One of the continuing problems is risk assessment and risk communication. How is the public made to understand that if an individual chooses to go out to a restaurant, order a food raw, and eat it raw, that individual has a certain amount of involvement in the risk if he or she gets sick? It is not necessarily the restaurant, the dealer, the supplier, the harvester, or anyone else (including the state health department) which did something wrong.

The Molluscan Shellfish workgroup was asked to consider the following points:

1. Discuss current state shellfish regulations, policies, and procedures in an effort to approach harmony among the five Gulf states.
2. Identify political and economic constraints which might serve an impediment to achieving Gulf-wide harmony.
3. Develop uniform policies and procedures.
4. Examine closures for other than National Shellfish Sanitation Program reasons.
5. Identify research needs.

Public Health Significance of Pathogens

There are two types of pathogenic microorganism transmitted to the consumer from the water by raw molluscan shellfish: 1) those that are naturally occurring marine organisms and 2) those that are pollution-related or man-induced pathogenic bacteria and viruses. Discussion in the group first attempted to determine which is the most significant. The work panel got very quickly into what turned out to be the foundation for the rest of the session, i.e., "perception of significance". The discussion centered around the fact that if there are a few deaths, say from Vibrio vulnificus, there is a real problem. It's in the press, everybody is concerned about it, and there may have been a number of lawsuits filed. That is your most significant public health problem. From a perception standpoint that may be true. But from a true public health protection standpoint (and this is difficult to say), a few deaths are more acceptable than a few thousand illnesses. From a true public health perspective, those things that something can be done about are the most important. Those pathogens that are a result of man's contribution to the environment are of greater significance. First, something can be done about them (there are some control mechanisms), and second, they are certainly the cause of the majority of illnesses. Therefore, they are of more public health significance even though others, which nothing can be done about, grab the headlines and our concerns.

The pathogens of concern were ranked in descending order: naturally occurring with the perception of high significance, and sewage related pathogens which are of more significance, because they are more widespread and cause more illnesses. Within the sewage related category, viruses are the cause of most illnesses, with hepatitis A and hepatitis non A non B being the most severe, and Norwalk and SRV's and other unclassified viruses causing the majority of illness. Following the viruses in number of cases are bacteria, specifically Vibrio cholera-01, Salmonella, and Shigella.

Conformance with the NSSP/ISSC

There is a control mechanism in the NSSP and the ISSC. The panel generally agreed that the guidelines that do exist, based on the currently available knowledge and technology, are as good as can be gotten. There is a problem with the current indicator organism. But in the absence of completion of the indicator study, the rest of the NSSP is as good as it can get at this point. The reason that the ISSC exists is to deal with those minor changes that need to be accomplished from year to year. Why aren't all the Gulf states applying these existing guidelines? All agree they are adequate, but all readily agree that probably none of the states, and certainly none of the states on the Gulf Coast, are adequately applying the existing guidelines. The reasons fall into three

major categories, the first being inadequate budgets. The second problem, ranked in order of significance, is politics. Politics can prevent actions based on public health. The third problem is a misconception and/or a lack of public health education in four specific areas: the industry, the legislature, the judiciary, and the public. This misconception and lack of understanding results in inadequate budgets because legislatures don't understand the preventive nature of classification and inspection activities. It also result in inadequate patrol and enforcement because the judiciary doesn't understand the public health significance of shellfish closures.

Problem areas were categorized into three groupings: growing areas (area classification, patrol, and illegal harvesting), penalties, and judicial support. Unfortunately, there are a lot of people in regulatory agencies who do not understand the industry. Either because they don't, or don't want to understand the industry, they create a lot of their own problems. Regulations are enacted without even considering the effect on the industry. Full understanding, not only of the industry and how it works, but of the effects proposed regulations may have on that industry should be promoted.

Growing Areas

Harvesting of shellfish has been a part of life on the Gulf Coast since prehistoric times as evidenced by shell mounds. The first and the foremost recommendation is that the level of pollution in the Gulf Coast estuaries should be reduced to the point that consumption of raw shellfish harvested from them does not pose a health risk. That is a pretty optimistic objective, but that's what the whole Gulf of Mexico Initiative is all about. A program should be in place so that consumption of raw shellfish does not pose a health risk. There should be a balance among areas meeting approved criteria, areas meeting conditionally approved criteria and open only under certain conditions, and areas meeting restricted criteria requiring transplanting. Sufficient budgets should be provided to state agencies to enable them to conduct sanitary surveys of all growing areas. One of the major problems is that states don't have funds to conduct sanitary surveys. Transplanting or depuration should not be developed or considered as an alternative to the Clean Water Act.

There are some things which were not discussed in much detail, such as the national indicator study. But the panel did strongly support the funding and completion of that study as quickly as possible. There were a couple of fairly specific things that were discussed, such as ISSC established criteria for opening of conditionally approved areas which have been temporarily closed. Those will be addressed to the Conference and deliberations will be made through that body.

As far as patrol and illegal harvesting are concerned, budgeting is one of the primary constraints. There aren't enough people to go out and adequately patrol areas, particularly on nights, weekends, and holidays. In addition, one of the bigger problems that keeps cropping up is lack of education in the industry and the judiciary. If the industry and the public understood the significance of illegal shellfish harvesting, then a lot of the illegal harvesting simply wouldn't occur. But a lot of fishermen don't understand that. They have been told that illegal harvest is against the law, but they have never been told why. There is a need for some kind of education program for the industry, and for the public so they will support management programs.

Penalties and Judicial Support

The judiciary needs education so that those who fish illegally will be punished adequately. Make no mistake, there always will be some who, no matter what you tell them, are going to harvest illegally. What is needed then is a judicial system that will respond and treat this in its proper perspective. It is a health problem, not a game violation. Too many people don't understand that, including the judiciary. But how does one go about educating the judge? There are a number of ways to educate the judiciary, the prosecuting attorneys and the judges, about the real significance of shellfish violations. There was uniform agreement that in some states confiscation and forfeiture of equipment used in illegal harvesting could be an effective deterrent. The recommendation is that, in those states where it would be effective, such confiscation and forfeiture should be implemented.

The group then discussed providing a uniform tag for all Gulf states to use and finally came up with the conclusion that the tag really isn't the problem. The problem is the tagging procedure. The conclusion is very simple. The intent of tagging shellfish is to provide for tracing of shellfish back through the system to the harvester and the harvest area. The tagging system is only as good as the honesty of the person filling out and attaching the tag to the shellfish. There are five different procedures in five different states for either purchase of or attaching tags. Filling out the information is pretty much the same in all states, but purchasing and attaching tags are different in every state. Yet, in each state, the system seems to work. The problem is those people who are willing to go into an illegal area to harvest shellfish and write on the tag that the product was harvested from an accepted or approved area. As long as that situation exists, there are going to be problems. The group again recommended education for the industry regarding the public health significance of illegal harvesting. That is the mood right now at the national level. Education is a major problem.

Non-NSSP Closings

Regarding closures for those things that are not specifically covered in the manual, the group agreed that these have to be handled on a case-by-case basis, depending upon public health significance. The specific example considered was, where one state closed an area because of high plate counts and another didn't. With a little more discussion, it became clear that if it's not covered in the NSSP, it has to be handled case-by-case. The group recommends improved coordination among states and among agencies. Those problems that do turn up to have sweeping intents or implications, should be recommended back to the ISSC to be covered in the Manual.

Risk Assessment and Individual Responsibility

The group discussed what probably is the real question in everybody's mind, i.e., "What is the responsibility of the public and the individual in consuming raw molluscan shellfish?" A lot of hard work was undertaken trying to formulate just the right words:

"There is no risk-free situation. It's that simple. In the consumption of raw shellfish, consider the following. Shellfish are harvested from a multiple-use estuarine system affected by man's waste; they are non-moving, filter-feeding organisms; they can not get away from pollution; and they concentrate the levels of that pollution to many times higher than to what they are exposed. In addition, they may be consumed live, raw and whole including the intestinal tract. Therefore, the person who chooses to consume molluscan shellfish raw must accept some risk.

In efforts to minimize this risk, a program involving FDA and all shellfish producing states exists to properly classify growing areas, to control harvesting, and to produce shellfish which have the lowest reasonable risk. Shellfish which are harvested from a properly classified area and are handled properly may still present health risks to certain target consumers because of naturally occurring marine organisms. This target group consists of those persons with underlying health concerns, primarily liver or blood-related problems, compromised immune system or stomach problems which result in reduced acid production after treatment. The risk to this target group is undefined. Under existing knowledge, no controls program can be designed, short of banning the consumption of raw

shellfish. This target group should not consume any raw shellfish and must assume all risk if they choose to do so.

Although any illness or death due to consumption of raw shellfish are regrettable, there is a number that will occur if consumption of raw shellfish exists. This number must be kept in perspective with other daily risks to which individuals are exposed: tobacco, alcohol, automobile accidents and many other common activities. The public should support the adequate funding of state and federal shellfish and pollution abatement programs. This will not only accomplish public health objectives, but because shellfish harvesting is the most restrictive use for estuarine areas, cleaning these areas to the level where shellfish can be harvested will result in a cleaner total environment."

Recommendations for EPA

The group recommends EPA should promote and participate in educational programs. There are a number of those that were mentioned as specific recommendations:

EPA should notice and encourage states to notice coastal activities that are inconsistent with shellfish harvesting. Many times a permit situation will occur where a discharge permit will be applied for, considered and granted and the discharge will meet permit parameters. From an environmental protection standpoint it may be a perfectly acceptable discharge. But from a public health or a shellfish harvesting standpoint, it may be a totally unacceptable discharge. Coordination between the two should be promoted. Some of the discharges must meet more restrictive public health requirements rather than just being permitted according to environmental protection. EPA should be aware of the differences between protecting the environment and protecting public health, and further, EPA should promote this understanding by state-level EPA programs. State level EPA programs should understand public health and shellfish concerns and should promote coordination of permitting activities. EPA should coordinate and sponsor intrastate workshops with public health, shellfish, resource, wildlife and water agencies and any other appropriate agencies to facilitate interstate and interagency coordination.

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HUMAN EXPOSURE TO PATHOGENS IN SEAWATER

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The workgroup on Human Exposure to Pathogens in Seawater was asked to consider the following points:

1. Discuss the currentness of the 1986 EPA Bacteriological Ambient Water Quality Criteria for Marine and Fresh Recreational Waters.
2. Identify emerging concerns and research issues regarding bacterial pathogens in recreational waters to continually update criteria and standards.
3. Discuss current Gulf state regulations, policies and procedures on compliance with the 1986 bacteriological criteria.
4. Arrive at consensus to develop a uniform approach to implementing criteria values.
5. Discuss the roles that EPA could play in risk assessment, management and communication of risk regarding bacteriological hazards in recreational waters.
6. Identify research needs.

A summary of the group discussion of these agenda items is as follows:

Currentness of the 1986 EPA Bacteriological Ambient Water Quality Criteria for Marine and Fresh Recreational Waters

Dr. Al DuFour, USEPA Cincinnati, gave a brief overview of studies done since the criteria document was released which substantiates the earlier studies showing a correlation between indicator organisms and swimmer-related illness.

The work group acknowledged the validity of the new criteria organisms (E. coli and Enterococcus) as indicators of health effects.

The group expressed a need for pilot side-by-side testing of the new and old indicators by individual states to:

- * Test the ease of field sampling and the level of difficulty of laboratory analysis;
- * Develop a data base to help explain and support the conversion to new standards from the public relations viewpoint;
- * Develop a data base to attempt a cost/benefit analysis of conversion to new standards;
- * Reduce the possibility of inappropriate closures of recreational resources and the resulting economic consequences;
- * Determine how each state will use the health effects standard for other regulatory purposes.

Emerging Concerns

A number of concerns were expressed regarding the new indicators and issues peripheral to adoption of new standards. There were concerns over:

- * Having one indicator for oyster growing waters and others for recreational waters;
- * Inability of the indicators to distinguish between human and animal sources of waste;
- * The potential requirement that indicator levels be met at the discharge outfall to meet the "fishable-swimmable" mandate;
- * The classification of a given water body and its implications for discharge limits and regular standards attainment;

- * The efficacy of indicator values for small sources such as septic tanks and small package plants;
- * Resistance to the use of public health based criteria in states using fecal coliforms as an overall indicator of the quality of aquatic habitats;
- * Resistance of labs and dischargers to employing new test procedures;
- * The cost of compliance with the new standards;
- * Education of the public as to the unavoidable risks associated with swimming in natural recreational waters;
- * Failure of new indicators to reflect the presence of naturally occurring opportunistic pathogens in recreational waters;
- * Competing priorities and funding levels which may delay implementation of new standards;
- * Sister agencies with different aspects of responsibility implementing different standards and/or lack of interagency cooperation.

Current Gulf State Regulations, Policies and Procedures on Compliance

In general, the Gulf states are not overly eager to adopt the new criteria organisms and would like more data on which to make the decision.

Alabama is currently involved in a triennial water quality standards review, with adoption of proposed revisions scheduled in 1990. Because of other priority water quality standards issues, no changes were proposed with respect to bacteriological criteria. The existing criteria are based on fecal coliform and are 100/100 ml in coastal waters and 200/100 ml in other waters. Consideration of the new indicators will likely be addressed in the next triennial review. Before changes are proposed however, additional information in the form of comparative studies, costs, etc. will be necessary.

The Florida Department of Environmental Regulation uses coliform standards, not the new criteria organisms. Other agencies which would use the new criteria if implemented would be the Florida Department of Health and Rehabilitative Services (Bathing Beach Standards). Florida is currently funding a small study to examine the new indicators (developing a side-by-side data base). Florida is hesitant to implement the new standards which are directed

toward bathing beach areas. Florida's water quality classification has a broader scope than the bathing beach category and must be concerned about other applications as well.

Louisiana is currently using the fecal coliform criteria as its water quality standard for bacteria. However, a large number of water bodies are out of compliance with the present fecal coliform standard, but have few dischargers and no history of waterborne disease. Therefore, Louisiana is reviewing the 1986 EPA criteria for adoption into the state water quality standards.

The Mississippi Department of Environmental Quality, Bureau of Pollution Control, is the agency responsible for classifying waters and adopting water quality criteria for the state of Mississippi. The department is currently conducting a triennial review of water quality criteria. However, adoption of the proposed bacteriological criteria is not currently being considered. Region 4 of EPA has not been pushing adoption at this time. Mississippi is interested in adopting a criteria which will more accurately reflect public health risks, however, a review of the data comparing the existing fecal coliform criteria with the new proposed indicators must be done before taking action.

The Texas standards remain based on fecal coliform bacteria, with a criterion of 200/100 ml for contact recreation (geometric mean) and a criterion of 14/100 ml for oyster waters (applied as a median). Contact recreation criteria are designated for virtually all coastal waters (Houston Ship Channel excepted); and fecal coliform bacteria are sampled at 174 fixed stations in tidal waters. The Texas Water Commission establishes water quality standards and regulates pollution sources, while the Texas Department of Health has the authority to close areas for shellfishing and swimming.

One important point is that regulations are adopted to protect health by agencies other than health departments in all of the states. Health departments are not responsible for setting ambient water quality standards.

Consensus

The group easily reached consensus that the data on new indicators developed to date show that they are better predictors of swimming-related health effects than the old standards. However, there is not necessarily consensus on how individual states will apply the new criteria values for their individual needs.

Reaching consensus will require:

- * State sampling programs with similar protocols, QA/QC methods and documentation;

- * Exchange of sampling data and information including the economic implications of adopting new standards among sister agencies with responsibility allocated between EPA and states among states;
- * Agreement to accomplish the above by state agency directors and regional EPA representatives;
- * Recognition of regional ecological differences and pollution sources in the Gulf with the aim of segmenting the Gulf into regions for implementing new bacterial standards for recreational waters.

General Recommendations

The following recommendations were offered by the group regarding implementation of the new bacteriological criteria for recreational waters:

- * Interagency cooperation in developing and implementing new recreational water standards should be fostered, including agreements for information and data exchange.
- * Technical outreach by EPA to aid states with education and implementation of new standards should be continued.
- * All Gulf states should be encouraged to adopt the same methods of sampling and analysis for microbial indicators. This could be initiated through a workshop for state laboratory personnel.
- * Sanitary surveys done by states should be continued to identify and eliminate sources of fecal contamination that impact recreational water quality.
- * Seasonal and/or alternative chlorination practices should be examined for point sources during non-swimming intervals (winter, low water conditions, etc.).

In the risk communication area, EPA should:

- * Develop a list of all agencies responsible for water quality and/or resource closure. Give seminars to personnel in these agencies on data interpretation and risk communication.
- * Encourage the Technical Steering Committee to keep states abreast of new Gulf of Mexico Program activities.
- * Advise the public early in the process of developing and implementing the new recreational water bacteriological standards - via citizen workshops, brochures or the Gulf Fact Sheet.

- * Tap citizen groups, through the Citizen Advisory Committee, as a source of information on risk perception and as a source of data on cases of swimming-associated illness.
- * Include the topic of recreational water quality in the upcoming Status of the Gulf Symposium.
- * Include data on bacteriological quality of recreational waters in the new electronic bulletin board.
- * Outline possible uses of the new indicators for non-public health applications such as effluent limitations, ocean outfalls and other environmental impacts.

Research Recommendations

The workgroup felt that the following research efforts are needed:

- * There should be a region-wide study, using the same study protocol to develop a regional data base. The study should be funded by EPA and coordinated through the EPA Gulf of Mexico Program.
- * A study should be conducted to determine the risk from exposure to non-point sources (animal) vs. risk from exposure to human waste (as in the National Indicator Study for Shellfish).
- * A project to define the transport of indicators from the source to the target area and to define the fate of indicators in marine and fresh waters is needed.
- * Rapid/better methods for detecting opportunistic pathogens are necessary.

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**MARINE BIOTOXINS AND ASSOCIATED
PUBLIC HEALTH RISKS IN THE GULF OF MEXICO**

Introduction

Marine biotoxins are natural products produced by a variety of marine plants and animals. Marine dinoflagellates, algae classified under the division Pyrrhophyta are the most prolific biotoxin producers known, and therefore are of primary concern. However, other divisions of algae, bacteria and cyanobacteria also are documented to produce biotoxins which impact human health. Many biotoxins can accumulate in important seafood species in the marine environment and cause human illness when consumed. A few of the biotoxins can become airborne in coastal aerosols causing respiratory irritation and others are known to cause contact dermatitis. Most of the known biotoxins are heat stable, odorless, colorless and otherwise completely undetectable by the human senses. In most cases there are no methods of seafood preparation by which biotoxins can be purged from suspect seafood. Detection of biotoxins in seafood products is possible by cumbersome methods in laboratory settings. However, enzyme-immunoassay technology for generic detection of some biotoxins is rapidly approaching the point of commercial application.

The Marine Biotoxins workgroup was asked to consider the following points:

- * List, briefly define and rank the present and potential marine biotoxin threats to public health in the Gulf of Mexico. Definition should include, if possible, acceptable risk levels (e.g., toxin content in fishery products or progenitor concentrations in coastal waters).
- * Assess the adequacy of knowledge concerning the existence of toxin progenitors in the Gulf. (e.g., is there reason to believe that there are unidentified toxin producers in the Gulf which represent a threat to public health). Recommend and prioritize research needs.
- * Assess current ability to detect and distinguish marine biotoxins in fishery products and natural environments.
- * Identify toxin detection methods which can be applied, those which need improvement, and those for which methods are not available. Recommend and prioritize research needs.
- * Assess current ability to predict the occurrence of "Red Tides" or other non-tide forming toxin progenitors in the Gulf of Mexico.

* Identify predictive methods which can be applied, those which need improvement, and those for which methods are not available. Recommend and prioritize research needs.

* Assess the adequacy of existing monitoring programs for "Red Tides"/marine toxin events.

* Determine whether such programs could or should be adopted Gulf-wide.

* Assess current ability to respond to marine toxin events, ("Red Tide" events, human poisonings, exposure to toxic aerosols, etc.).

* Identify means to improve responsiveness (e.g., is the expertise required to identify and manage a marine toxin event widely available, or should an EPA-sponsored "response team" be recommended?)

* Determine what actions the EPA Gulf of Mexico Program might take to improve public understanding of the public health implications of marine toxins.

The following is a categorized synopsis of discussions and recommendations put forth by the Marine Biotoxins work group. It represents a summary of the issues and topics which the panel members were able to arrive at a consensus on.

Assessment of Marine Biotoxins in the Gulf of Mexico

In the Gulf of Mexico (Gulf) there are two definite, three probable and several potential marine biotoxin threats to public health. Biotoxin threats not originating in the Gulf will not be discussed. Human illness caused by Neurotoxic Shellfish Poisoning (NSP) and Ciguatera Fish Poisoning (Ciguatera) are the predominant forms of seafood poisoning in the Gulf:

NSP is distributed Gulf-wide from south Florida to south Texas. It is caused by consumption of shellfish which have accumulated toxins produced by the microscopic dinoflagellate Gymnodinium breve. This organism can form extensive Red Tides which have also been responsible for massive marine life mortalities and irritating aerosols in the Gulf and along the U.S. southeast coast. Gymnodinium breve red tides are perennial in southwest Florida, and noteworthy red tides were also recorded in Corpus Christi Bay, TX and Onslow Bay, NC in 1986 and 1987 respectively.

Ciguatera is distributed world-wide in subtropical and tropical latitudes. In the Gulf of Mexico it is prevalent in south Florida and possibly south Texas. Ciguatera is caused by consumption of finfish which have accumulated toxins produced by several species of microscopic dinoflagellates (Gambierdiscus toxicus, Prorocentrum

concaum, P. lima, Ostreopsis lenticularis & O. siamensis). Outbreaks of ciguatera are sporadic and unpredictable, and are not preceded by algal bloom or red tide events. The most recent outbreak in the Gulf region occurred in south Florida in 1988. Three probable marine biotoxin threats include Diarrhetic Shellfish Poisoning (DSP), Amnesic Shellfish Poisoning (ASP) and Tetraodon Fish Poisoning (Pufferfish Poisoning).

DSP has been reported from Japan, southeast Asia, western Europe and South America. This illness is caused by the consumption of shellfish which have accumulated toxins produced by several species of the dinoflagellate genus Dinophysis and possibly Prorocentrum. Human illness caused by DSP has not been confirmed from the Gulf Coast, however, several species of Dinophysis implicated in toxicity of shellfish elsewhere have been identified from Gulf waters. Furthermore, because of the close similarity in human symptomatology it is possible for DSP to be mis-diagnosed as a commonplace bacteria-related gastrointestinal disorder. Outbreaks of DSP are not necessarily preceded by algal bloom or red tide events. Low levels of the causative dinoflagellates over shellfish beds are sufficient to cause toxicity in shellfish.

ASP has been reported only from Prince Edward Island of Eastern Canada. Circumstantial evidence also suggests the occurrence of ASP in the Northeast U.S. This illness is caused by the consumption of shellfish which have accumulated toxins produced by the diatoms Nitzschia pungens f. multiseries and Amphora coffaeiformis. Algal bloom or red tide events appear to precede the occurrence of toxic shellfish. Confirmed cases of ASP have not been reported from the Gulf Coast, however, N. pungens has been identified in plankton samples taken from Galveston Bay. As is the case with DSP medical records have not been evaluated for undiagnosed or possible mis-diagnosed symptoms corresponding to this form of seafood poisoning.

Pufferfish Poisoning has been recorded throughout the Pacific and from Puerto Rico in the Atlantic Ocean. This illness is caused by the consumption of pufferfish (blowfish) which have accumulated tetraodotoxin, a potent toxin of unconfirmed origin. Human cases of pufferfish poisoning have not been reported from the Gulf of Mexico. Insufficient information is available to determine the potential for this type of seafood poisoning in the Gulf of Mexico. However, the toxicity of pufferfish is generally thought to be widespread.

Other potential biotoxin threats are represented by species which are known to be toxic but are poorly understood in the Gulf of Mexico. These species include Alexandrium tamarensis, A. monilatum, A. tropicale, Gymnodinium catenatum, G. nagasakiense, Prorocentrum minimum, P. treistenum & P. lima. Several species of toxic Chloromonads, marine bacteria and cyanobacteria also are known to exist in the Gulf of Mexico and elsewhere. None of the

above species have been associated with human illness in the Gulf of Mexico.

Adequacy of Knowledge on Biotxin Producers

With the exception of G. breve, the causative organism of NSP, all of the biotoxin producers mentioned above were discovered only recently. As an example, the toxicity of N. pungens and the clinical definition of ASP were first described in 1988. Others like A. tropicale, G. nagasakiense, and P. treistenum are yet to be studied in relation to public health. In all cases, including G. breve, informational needs still exist. With regard to the biology of the biotoxin producers information is needed in several categories including; 1) the occurrence and distribution of the known and potentially toxic species, both motile and encysted; 2) the modes of toxin impact on human health and the probabilities of symptomatic masking, incomplete or mis-diagnosis; 3) the quantitative degrees of biotoxin production, biotoxin distribution in fish and shellfish tissues and persistence of biotoxins in fish and shellfish tissues; 4) the natural and anthropogenic factors which promote the growth and dispersion of biotoxin producers; 5) the physical factors involved in the initiation, propagation, transport and termination of blooms or red tides; 6) the extent and potential for acute and chronic impact on human health; and 7) the epidemiological assessment of seafood poisonings and the development of remedial medical treatments.

Recommended actions to address some of these informational needs include support of: 1) increased field study and surveillance which should include the improvement of remote sensing (satellite & aircraft) technologies for detecting blooms and red tides at early stages of development and the use of conventional field sampling and monitoring by sea-going vessels with improvement and standardization of methods for the detection and characterization of motile populations and cyst beds; and 2) laboratory studies on the physiological ecology, biotoxin production and potency in a cross-section of clonal, population and cyst isolates as well as spatial and temporal isolates of biotoxin producers.

The National Oceanic and Atmospheric Administration (NOAA) "CoastWatch" program will be of benefit in addressing some of these informational needs. NOAA produces near real-time data products using its environmental satellites along with oceanographic data for unusual environmental events in the South Atlantic Bight. Weekly summaries of sea surface temperature, wind drift, Ekman transport, and other information are distributed via NOAA Fisheries to a network of scientists and state and federal agencies concerned about outbreaks of red tide. CoastWatch programs for other regions of the United States, such as the Gulf of Mexico, are in the planning stage.

Current Methods for Detecting Biotoxins

Detection methods for biotoxins in microorganisms, seafood products, seawater and seawater aerosols have in most cases not been transferred beyond the laboratory setting. Analyses or bioassays for biotoxins are in most cases responsive, taking place after episodes of human illness. This is because there are no monitoring programs for biotoxins in many states, and because the available detection methods are complicated and cumbersome. New and simplified methods for detecting some of the marine biotoxins are presently in or near an applied stage of development. These methods which are based upon immunochemistry hold great promise for rapid, reliable, and publicly accessible detection methods for biotoxins.

The historical method for biotoxin detection is the mouse bioassay which has been adequate in many situations where a simple positive or negative answer is required. However, this bioassay lacks the sensitivity and specificity needed to address the growing number of biotoxins discovered in seafoods. With regard to NSP and paralytic shellfish poisoning (PSP) the latter a possible health risk in the Gulf, the mouse bioassay has been standardized through the Association of Official Analytical Chemists. These standardized bioassays are employed by state sponsored NSP and PSP monitoring programs in Florida and coastal states of the Northeast and Northwest U.S., respectively. The mouse bioassay has been used with other biotoxins listed, however, standardization has not been possible because of the unavailability of biotoxin standards or an incomplete understanding of the biotoxins involved.

Technical methods of detection utilized in laboratory settings include High Performance Liquid Chromatography (HPLC) and HPLC-Mass Spectrometry. Methods for detecting most of the known biotoxins have been developed using these analytical instruments. Both offer greater sensitivity and specificity in the identification of biotoxins, however these methods are highly technical and suitable only for centralized laboratory monitoring programs.

Recent progress in immunochemistry has resulted in the development of biotoxin assays generally referred to as Enzymeimmunoassays (EIA). The EIA relies upon the natural sensitivity and selectivity of immune system antibodies which can be developed against biotoxins under appropriate conditions. The EIA offers sensitivity equivalent to analytical instrumentation and specificity which is more or less chemically generic. Generic specificity may prove to be advantageous in cases where seafood poisonings are caused by several chemically related biotoxins. Another critical advantage of the EIA is the adaptability of these assays to formats suitable for simplified field use. EIA's in various stages of refinement have been developed for DSP, NSP, PSP and for ciguatera. Related methods known as Radioimmunoassays

(RIA) also have been developed for NSP and ciguatera but these methods cannot be employed in field situations.

The recovery and analysis of biotoxins from the water column and from aerosols is not well developed. Methods of recovery from the water column currently include liquid/liquid extraction and solid sorbent extraction. Recovery from aerosols is more difficult and currently involves high volume air samplers. Biotoxin detection from these samples is by mouse bioassay and HPLC.

Recommendations for the development of biotoxin detection methods include support of: 1) research on the identification of poorly characterized biotoxins from known and suspected toxigenic algae, bacteria and cyanobacteria from the Gulf of Mexico; 2) research and development on methods for recovering biotoxins from environmental samples; 3) continued development and improvement of analytical methods for unambiguous determinations from biological and environmental samples; and 4) continued research and development on immunochemical methods as preemptive detection tools.

Monitoring Programs and Predictive Capabilities

With the exception of Florida, organized state monitoring programs for marine biotoxin producers in the Gulf of Mexico do not exist. Because of the longer history of human illness and economic damage caused by Gymnodinium breve, Florida has instituted a program to monitor this organism in coastal waters. However, this program operates in an incident-induced fashion, is labor intensive and does not accurately predict the occurrence of red tide events. Progress has been made in the inclusion of satellite remote sensing to improve surveillance of G. breve in coastal waters. This program has been successful in reducing the incidence of NSP through surveillance and selective closures of affected shellfish grounds. Follow-up monitoring of shellfish toxicity in affected areas is conducted and tolerance levels for biotoxin content have been specified. Monitoring programs do not exist for other biotoxin producers.

The institution of Gulf-wide monitoring programs for biotoxin producers is recommended. Considerable improvement is needed in methods of surveillance and standardization. Support for the development and use of satellite and aircraft remote sensing in combination with ground truthing is highly recommended. Inter-regional communication and cooperation, and international collaboration with Mexico should be encouraged. It is recommended that a Gulf-wide advisory team be designated and composed of individuals knowledgeable in the assessment and management of red tide and other marine biotoxin events. An advisory team might provide specialized training and organizational structure to local authorities responsible for dealing with public health threats.

Public awareness and understanding of health risks associated with biotoxins can be improved by release of pertinent information to the popular literature, pamphlet distribution, "Nova" type television programing or presentations to civic groups and governments. The encouragement of public feedback to local health departments might also augment monitoring capabilities for biotoxin producers in the Gulf of Mexico.

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SUMMARY AND RECOMMENDATIONS

All three workgroups performed an exemplary task of carrying out the charges put before them. The major goal envisioned by the meeting organizers was the formation of a series of recommendations outlining the role the Gulf of Mexico Program (GOMP) should play in bringing advancements in public health research and information transfer to fruition. There was a general agreement among the workgroups that GOMP's program structure would easily lend itself to assume the role of Gulf-wide catalyst and facilitator in issue areas which cut across state and agency boundaries and perceived areas of responsibility. The following is a summary of work group recommendations to EPA's Gulf of Mexico Program by subject matter area.

Molluscan Shellfish

- * The level of pollution in Gulf Coast estuaries should be reduced to the point that consumption of raw shellfish harvested from them does not pose a health risk.
- * Sufficient budgets should be provided to state agencies to enable them to conduct sanitary surveys of all growing areas.
- * Transplanting or depuration of shellfish should not be developed or considered as an alternative to the Clean Water Act.
- * In those states where it would be effective, confiscation and forfeiture of equipment used in illegal harvesting should be implemented.
- * The shellfish industry, the judiciary, and the public should be further educated regarding the public health significance of illegal harvesting.
- * Coordination among states and agencies of the sanitary control of shellfish must be improved, but on a case-by-case basis. The National Shellfish Sanitation Program, and Interstate Shellfish Sanitation Conference should play the lead role in this activity.
- * Information about the transmission of disease via molluscan shellfish should be publicized in such a manner that the public will support adequate funding of shellfish growing water pollution abatement programs.
- * EPA should promote and participate in educational programs.
- * EPA should notice and encourage states to notice coastal activities that are inconsistent with shellfish harvesting.

* EPA should be aware of the differences between protecting the environment and protecting public health, and further, EPA should promote this understanding by state-level EPA programs. State-level EPA programs should understand public health and shellfish concerns and should promote coordination of permitting activities.

* EPA should coordinate and sponsor intrastate workshops with public health, shellfish, resource, wildlife and water agencies and any other appropriate agency to facilitate interstate and inter-agency coordination.

Direct Contact

* Interagency cooperation in developing and implementing new recreational water standards should be fostered, including agreements for information and data exchange.

* Technical outreach by EPA to aid states with education and implementation of new standards should be continued.

* All Gulf states should be encouraged to adopt the same methods of sampling and analysis for microbial indicators. This could be initiated through a workshop for state laboratory personnel.

* Sanitary surveys done by states should be continued to identify and eliminate sources of fecal contamination that impact recreational water quality.

* Seasonal and/or alternative chlorination practices should be examined for point sources during non-swimming intervals (winter, low water conditions, etc.).

In the risk communication area, EPA should:

* Develop a list of all agencies responsible for water quality and/or resource closure. Give seminars to personnel in these agencies on data interpretation and risk communication.

* Encourage the Technical Steering Committee to keep states abreast of new Gulf of Mexico Program activities.

* Advise the public early in the process of developing and implementing the new recreational water bacteriological standards - via citizen workshops, brochures or the Gulf Fact Sheet.

* Tap citizen groups, through the Citizen Advisory Committee, as a source of information on risk perception and as a source of data on cases of swimming associated illness.

* Include the topic of recreational water quality in the upcoming Status of the Gulf Symposium.

* Include data on bacteriological quality of recreational waters in the new electronic bulletin board.

* Outline possible uses of the new indicators for non-public health applications such as effluent limitations, ocean outfalls and other environmental impacts.

* There should be a region-wide study, using the same study protocol to develop a regional data base. The study should be funded by EPA and coordinated through the EPA Gulf of Mexico Program.

* A study should be conducted to determine the risk from exposure to non-point sources (animal) vs. risk from exposure to human waste (as in the National Indicator Study for Shellfish).

* A project to define the transport of indicators from the source to the target area and to define the fate of indicators in marine and fresh waters is needed.

* Rapid/better methods for detecting opportunistic pathogens are necessary.

Marine Biotoxins

* EPA should support increased field study and surveillance which should include the improvement of remote sensing technologies for detecting algae blooms and red tides at early stages of development and the use of conventional field sampling and monitoring by sea-going vessels with improvement and standardization of methods for the detection and characterization of motile populations and cyst beds.

* EPA should support laboratory studies on the physiological ecology, biotoxin production and potency in a cross-section of clonal, population and cyst isolats as well as spatial and temporal isolates of biotoxin producers.

* Research is needed for the identification of poorly characterized biotoxins from known and suspected toxigenic algae, bacteria and cyanobacteria from the Gulf of Mexico.

* Research and development on methods for recovering biotoxins from environmental samples is needed.

* Development and improvement of analytical methods for unambiguous determinations from biological and environmental samples should be continued.

* Research and development on immunochemical methods as preemptive detection tools should be pursued.

* Gulf-wide monitoring programs for biotoxin producers should be instituted. Considerable improvement is needed in methods of surveillance and standardization. Remote sensing programs such as NOAA's "CoastWatch" should be implemented in the Gulf of Mexico.

* Inter-regional communication and cooperation and international collaboration with Mexico should be encouraged.

* A Gulf-wide advisory team, composed of individuals knowledgeable in the assessment and management of red tide and other marine biotoxin events should be designated. This team might also provide specialized training and organizational structure to local authorities responsible for dealing with public health threats.

* Public awareness and understanding of health risks associated with biotoxins might be improved by release of pertinent information to the popular literature, pamphlet distribution, "Nova" type television programming or presentations to civic groups and governments. The encouragement of public feedback to local health departments might also augment monitoring capabilities for biotoxin producers in the Gulf of Mexico.

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