

The Philosophical Society of Texas

PROCEEDINGS

1995

The Philosophical Society of Texas

PROCEEDINGS
OF THE ANNUAL MEETING

AT CORPUS CHRISTI

DECEMBER 1-3, 1995

LIX

AUSTIN
THE PHILOSOPHICAL SOCIETY OF TEXAS
1996

THE PHILOSOPHICAL SOCIETY OF TEXAS FOR THE COLLECTION AND DIFFUSION OF KNOWLEDGE was founded December 5, 1837, in the Capitol of the Republic of Texas at Houston by MIRABEAU B. LAMAR, ASHBEL SMITH, THOMAS J. RUSK, WILLIAM H. WHARTON, JOSEPH ROWE, ANGUS MCNEILL, AUGUSTUS C. ALLEN, GEORGE W. BONNELL, JOSEPH BAKER, PATRICK C. JACK, W. FAIRFAX GRAY, JOHN A. WHARTON, DAVID S. KAUFMAN, JAMES COLLINSWORTH, ANSON JONES, LITTLETON FOWLER, A. C. HORTON, I. W. BURTON, EDWARD T. BRANCH, HENRY SMITH, HUGH MCLEOD, THOMAS JEFFERSON CHAMBERS, SAM HOUSTON, R. A. IRION, DAVID G. BURNET, and JOHN BIRDSALL.

The Society was incorporated as a non-profit, educational institution on January 18, 1936, by George Waverly Briggs, James Quayle Dealey, Herbert Pickens Gambrell, Samuel Wood Geiser, Lucius Mirabeau Lamar III, Umphrey Lee, Charles Shirley Potts, William Alexander Rhea, Ira Kendrick Stephens, and William Embrey Wrathier. On December 5, 1936, formal reorganization was completed.

The office of the Society is located at 2.306 Sid Richardson Hall, University of Texas, Austin, 78712.

Edited by Ron Tyler, Janice Pinney, and Colleen Kain

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The Philosophical Society of Texas

TWO HUNDRED NINETY-THREE MEMBERS, SPOUSES, AND GUESTS GATHERED AT the Marriott Bayfront Hotel in Corpus Christi on December 1-3, 1995, for the Society's 158th anniversary meeting. President William H. Crook had organized an exceptional program on "The Oceans." The Friday evening reception and dinner was held at the Corpus Christi Museum of Science and History, where members had the opportunity to view some of the artifacts recovered from La Salle's ship *La Belle* and to visit the replicas of Columbus's ships. President Crook introduced the new members of the Society and presented them with their certificates of membership. The new members are: Blaine A. Brownell, Don E. Carleton, Ronald A. Crutcher, Isabella C. Cunningham, Margaret Belding de Wetter, John Hannah Jr., Nathan Lincoln Hecht, Patrick E. Higginbotham, Gerald Douglas Hines, Alfred Francis Hurley, Janis Graham Jack, Carolyn Dineen King, Richard S. Lombard, Joseph M. McFadden, John Mark McLaughlin, Charles Miller, Boone Powell, D. J. Sibley, Jerome H. Supple, Curtis Vaughan Jr., Louise Weinberg, and Fred Newton White Jr.

Bill Moyers served as moderator for the program on Saturday. We paused for lunch at the Marriott Bayfront Hotel. That evening Ambassador and Mrs. Crook hosted the society in a reception at their home, with the annual banquet at the Town Club. The Showcase band played throughout the dinner.

At the annual business meeting, Vice President Charles Sprague read the names of the seventeen members of the Society who had died during the previous year: Mary Joe Carroll, Katharyn Duff, J. Conrad Dunagan, Llerena B. Friend, Ruth Hartgraves, Erwin Heinen, Paul Horgan, Oveta Culp Hobby, John Erik Jonsson, George MacGregor, Abner McCall, Robert McGinnis, Herman Pressler Jr., Harry Mayo Provence, Ralph Spence, Margaret Symonds, and James Teague. Secretary Tyler announced that our membership stood at 192 active members, 67 associate members, and 35 emeritus members.

The following officers were elected for the coming year: Charles Sprague, president; Jack Blanton, first vice president; William P. Wright, second vice president; J. Chrys Dougherty III, treasurer, and Ron Tyler, secretary.

President Crook announced that Scott Stewart of Port Aransas won the President's Award essay contest and was present with us at the meeting. His essay is included on pages 99-102 of this issue of the *Proceedings*.

Following the Sunday morning discussion, President Crook declared the annual meeting adjourned, to be reconvened on December 6, 1996, in Dallas.

ATTENDANCE AT THE 1995 ANNUAL MEETING

Members registered included Misses Crook, Hayes, Hill, Lee; Mesdames Brinkerhoff, Carpenter, Cunningham, de Wetter, Hershey, Huey, Hutchison, Jack, Johnson, King, Lancaster, Mackintosh, Marsh, McCorquodale, McDermott, Moyers, Randel, Rhodes, Rostow, Temple, Vick, Weddington, Weinberg, Wilson, Zachry; Messrs. Anderson, Ashby, Bell, Blanton, Bobbitt, Brownell, Butt, Caldwell, Carleton, Crim, Crook, Crutcher, Cunningham, Curtis, Dobie, Dougherty III, Dougherty IV, Doyle, A. Baker Duncan, Charles Duncan, John Duncan, Farabee, Fehrenbach, Fisher, Durwood Fleming, Jon Fleming, Galvin, Garrett, Greenhill, Hannah, Hargrove, Harrigan, Harrison, Harte, Hecht, Hershey, Hilgers, Hines, Hoffman, Holtzman, Howe, Hughes, Hurley, James, Justice, Kessler, King, Kozmetsky, LaBoon, Law, Leberman, Levin, Lochridge, Lord, Love, Maguire, Margrave, Martin, McCombs, McKnight, McLaughlin, Middleton, Miller, Moody, Mullins, Murphy, Phillips, Pope, Powell, Edward Randall, Risher Randall, Rostow, Seybold, Sherman, Shilling, Shuffler, Sibley, Smith, Sprague, Staley, Steves, Storey Jr., Storey Sr., Sullivan, Supple, Sutton, Thomasson, Trotter, Trotti, Tyler, Veninga, Watkins, Weinberg, White, Whitmore, Whitten, Wildenthal, Woodruff, Worsham, Charles Wright, James Wright, and William Wright.

Guests included: Mr. Mark Adame, Mr. and Mrs. Tim Akard, Ms. Mary Altalo, Mr. and Mrs. Tony Amos, Mrs. Thomas Anderson, Mr. and Mrs. Barto Arnold, Mr. and Mrs. Kit Ashby, Mrs. Lynn Ashby, Mr. Robert Ballard, Mrs. Paul G. Bell, Mrs. Jack Blanton, Mrs. John Brown, Mrs. Blaine Brownell, Mr. Gary Bushell, Mrs. Clifton Caldwell, Mr. and Mrs. Armin Cantini, Mrs. Don Carleton, Mr. F. W. Carr, Mr. Michael Cave, Ms. Patsy Chaney, Mr. and Mrs. Walter Crawford, Mrs. William R. Crim, Mrs. William Crook, Mr. William Crook Jr., Mrs. Ronald Crutcher, Mrs. Greg Curtis, Mr. Peter de Wetter, Mrs. Dudley Dobie, Mr. and Mrs. Quenton Dokken, Mrs. Elinor Doty, Mrs. J. Chrys Dougherty III, Mrs. Gerry Doyle, Mrs. A. Baker Duncan, Mrs. Charles Duncan, Mrs. Ray Farabee, Mrs. T. R. Fehrenbach, Mrs. Richard Fisher, Mrs. Durwood Fleming, Mrs. Jon Fleming, Mrs. Martha Freeman, Mrs. Charles Galvin, Mr. and Mrs. Pete Garcia, Mrs. Jenkins Garrett, Mrs. Joe Greenhill, Ms. Judith Guthrie, Mr. Greg Ham, Ms. Ann Hamilton, Mrs. James Hargrove, Mr. and Mrs. Jim Hargrove, Mrs. Stephen Harrigan, Mrs. Edward Harte, Mr. George Heyer, Mrs. William Hilgers, Mrs. Gerald Hines, Mrs. Philip Hoffman, Mrs. Wayne Holtzman, Mr. and Mrs. Gene Hornstein, Mr. Griffin Huey, Mrs. Alfred Hurley, Mr. Ray Hutchison, Mr. David Jack, Mrs. Thomas James, Mr. Reagan Jensen, Mrs. William Justice, Mrs. James

Kessler, Mrs. Dan Kilgore, Mr. Melvin Klein, Mrs. George Kozmetsky, Mr. Olin Lancaster, Mr. John LaRue, Mrs. Thomas Law, Mr. Marc Lewis, Ms. Nancy Lewis, Mrs. William Levin, Mrs. Lloyd Lochridge, Mrs. Grogan Lord, Mrs. Ben Love, Mr. and Mrs. Lundgren, Mrs. Jane Mackintosh, Mrs. Jack Maguire, Ms. Raissa Marking, Mr. and Mrs. Robert Martin, Mrs. Red McCombs, Mrs. Robert McGinnis, Mrs. J. M. McLaughlin, Mrs. Harry Middleton, Mrs. Charles Miller, Mrs. Dan Moody, Mr. and Mrs. Clif Moss, Mr. Bill Moyers, Mrs. Charles Mullins, Mr. William Negley, Mr. Bill Otton, Mr. and Mrs. Thomas Parr, Mrs. Thomas Phillips, Mrs. Edmund Pincoffs, Mrs. Jack Pope, Ms. Jodie Potts, Mrs. Boone Powell, Mr. and Mrs. Cactus Pryor, Mrs. Edward Randall, Mrs. Risher Randall, Mr. and Mrs. Glynn Ray, Mr. Alec Rhodes, Mrs. Sue Rose, Mrs. William Seybold, Ms. Josephine Shanks, Mrs. Max Sherman, Mrs. Roy Shilling, Mrs. Ralph Shuffler, Mrs. D. J. Sibley, Mrs. Frank Smith, Mrs. Harlan Smith, Mrs. Charles Sprague, Mr. J. M. Spriegel, Ms. Louise Spurgin, Mrs. Thomas Staley, Mrs. Marshall Steves, Mr. Scott Stewart, Mrs. Charles P. Storey Jr., Mrs. Charles P. Storey Sr., Ms. Paula Stout, Mr. and Mrs. Rick Stryker, Mrs. Steven Sullivan, Mrs. Jerome Supple, Mrs. John F. Sutton, Mr. and Mrs. John E. Sutton, Ms. Camille Thomasson, Mrs. Charles Thomasson, Ms. Yvonne Tocquigny, Mrs. Robert Trotter, Mrs. Robert Trotti, Mr. and Mrs. John Tunnell, Mr. Ross Vick, Mrs. Fred White, Mrs. C. G. Whitten, Mrs. Kern Wildenthal, Mrs. Mary P. Williams, Mr. Wally Wilson, Mrs. Jos. Irion Worsham, Mrs. Charles Wright, Mrs. James Wright, and Mrs. William Wright.

THE OCEANS

WELCOME AND INTRODUCTORY REMARKS

WILLIAM H. CROOK

WELCOME TO THE 158TH ANNIVERSARY MEETING OF THE PHILOSOPHICAL Society of Texas. In the thirties here in Corpus Christi on this side of the rickety old causeway, there used to be a sign that read, "Welcome, Corpus Christi, Never Misty. A Room and a Bath, a Dollar and a Half."

Now, eventually, the larceny caught up with the city and they realized that on those foggy days people not only couldn't read the sign, they couldn't even see it. So they brought in Madison Avenue and they changed the slogan to "A Sparkling City by the Bay." Other things have changed. I doubt that you will get out without paying more tax than a dollar-and-a-half on your room. But, in the main, the welcome stands, and Corpus Christi is known for that welcome.

This is a city born on the wrong side of the Nueces River. It was founded more or less as a trading post that quickly turned into a smuggler's lair and a place of escape for both Mexican citizens and Texas citizens who were running from the law, and they all met and mixed here. The Spaniard who first saw the river named it the Nueces, or the river of nuts. And it wasn't entirely irrelevant for the early period. As a matter of fact, if you attend some of our local elections, you will know we still have a few of them around.

I want to especially welcome the new members. We saw them last night and heard something about them, and I want them to look us over. I know you're disappointed because we don't look much like philosophers. The truth of the matter is, we aren't real philosophers. We are all in transit. Some are further down the road than others. Some of us have barely reached the city limits sign. But we all are lovers and seekers after knowledge and wisdom. And this group of people, in my opinion, represents the dynamic of this state in every field—in science, in medicine, in the judiciary, in the arts, and in business. We invite the new members to relax and become one with us. Although we don't take ourselves too seriously, we do take this Society seriously. We sought you out. You didn't ask to join. And since you accepted, we expect from you full participation and attendance every year, if at all possible.

When I was taking Philosophy 101, I learned two things that I remembered about philosophy, that is you have the philosopher of the road and the philosopher of the balcony. We don't have any balcony philosophers here. These are all men and women who've struggled in life and succeeded,

elbowed their way sometimes through the main streets to get there. So, again, we have got a great gold vein in this Society to be tapped together. Get out your tablets, take your notes, and prepare for it.

At this time, Texas' answer to Will Rogers—Cactus?

Cactus Pryor:

I must go down to the seas again, to the lonely sea and the sky,
 And all I ask is a tall ship and a star to steer her by,
 And the wheel's kick and the wind's song and the white sail's shaking,
 And the gray mist on the sea's face and a gray dawn breaking.
 I must go down to the seas again, for the call of the running tide
 Is a wild call and a clear call that may be denied;
 And all I ask is a windy day with the white clouds flying,
 And the flung spray and the blown spume, and the sea-gulls crying.
 I must go down to the seas again to the vagrant gypsy life,
 To the gull's way and the whale's way where the wind's like a whetted
 knife;
 And all I ask is a merry yarn from a laughing fellow-rover,
 And quiet sleep and a sweet dream when the long trick's over.

“Sea Fever” by John Masefield

William Crook: It is my observation that the greater the individual, the more tedious his introduction. He or she gathers so many honors, so many degrees, fills so many positions, that you can list them all and still not know the individual. Such is the case with Bill Moyers. My wife read his vita the other night. We were both awed by it. And she said, I believe Bill Moyers is the only truly, truly humble man I've ever met. I waited. It was not amended, and it was not extended.

Bill has gathered by his voice to America so many honors that it would be a tedious introduction if I read them all, and he wouldn't have time, and the panel wouldn't have time, to speak. He has written six national best-sellers, non-fiction. He has received thirty Emmys. He has been called the most significant voice in television news, the communicator of the decade, and a great conversationalist.

It's easy for me to say this because my wife did not amend her statement. So I want to tell you that, in spite of all his virtues and his accomplishments, Bill Moyers sails under false colors; it doesn't make any difference that he didn't raise the colors. He sails under them: the concept that he's a great conversationalist. It takes two to make a conversation, or three, to exchange ideas and information. If you were to meet Bill out in the hall or somewhere, you'd go home to your spouse or your friends and say, I've just

had the greatest conversation I've ever had in my life with Bill Moyers. And they would say, What did he say? And you would have to say, Well, not very much. But I was brilliant. I waxed eloquent. I spoke the definitive word definitively. I soared with my concepts and my ideas.

And that's Bill's dark secret. He listens. He listens, not because he is doing a poll or seeking information. He listens because he respects what you have to say, what the elevator operator has to say. And, as far as his being humble, he sometimes carries bags for the porter, and he listens to the porter and learns interesting things about him.

Let me give you one clue, one thing to watch for. On the fateful day when Air Force One took off from Dallas with its terrible burden, Bill was aboard for the swearing in of the new President. They were strapped in, and, once they reached the altitude, he unstrapped himself and went forward to find the president gazing at the blind that was pulled down, as they all were on the plane.

I know what I would have said. I suspect you would have said the same thing. I would have said, "Can I get you something, Mr. President?" Bill Moyers asked, "What are you thinking, Mr. President?" And the answer he received, to me, is a key that would unlock the burdens that the presidents throughout the Cold War had carried. So watch him. He will learn a lot about you, but he will treat it with great respect. I give you Bill Moyers.

THE OCEAN WITHIN: MYTHS AND MEMORIES

BILL MOYERS, MODERATOR

I begin with a confession. I am not here because I know anything about the oceans that would justify my presence on the platform with these experienced and knowledgeable scientists. I am here because my friend Bill Crook, your president, asked me to come. Over the course of our forty-year friendship I have never been able to say no to Bill. So blame him for having a landlubber as the moderator for a weekend of discussions about the oceans.

I take my cue for this assignment from the humorist, Robert Benchley. He arrived to take his final exam in international law at Harvard to discover that it consisted of just one question: "Discuss the abstract of the international fisheries problem in respect to hatcheries protocol and dragnet and procedure as it affects (a) the point of view of the United States, and (b) the point of view of Great Britain." Benchley was desperate but he was also honest. So he wrote: "I know nothing of the point of view of Great Britain in the arbitration of the international fisheries problem and nothing about the point of view of the United States. I shall therefore discuss the question from the point of view of the fish."

That is my point of view this weekend. When I interviewed him on PBS, the literary critic George Steiner compared the role of the literary critic to that of a pilot fish. The pilot fish points the way to the giant creative specimen coming along behind it. It is an exciting role but a distinctly minor one. Journalism is like that. The important work this weekend belongs to the giant creative specimen whom it will be my pleasure to introduce. I've said on other occasions that we journalists are beachcombers on the shores of other people's experience and knowledge. I expect to go home with a treasure trove after listening to the experts Bill Crook and this Society have assembled this weekend.

Speaking of treasure troves, the *New York Times* reported this week that the Navy has begun to release a rich collection of data about the oceans that was clandestinely gathered during the long decades of the Cold War.

For almost half a century our government deployed thousands of ships, airplanes, submarines, and satellites to collect readings on ice depth, ice shape, ocean depth, sediment composition, sea-surface height, salinity, bioluminescence and the transmissibility of light. It was all done in secrecy because the information gathered was vital to the quiet war against the Soviet Union by vessels gliding stealthily through the sea hunting out the hidden assets of our adversaries.

Some of the most recently released data, for example, came from a Navy satellite that in the 1980s made gravity measures over all the world's

oceans in an effort to increase the accuracy of long-range missiles fired from submarines. Some came from the frigid arctic where to improve our side's ability in the deadly serious hide-and-seek games of nuclear-armed submarines the Navy amassed huge amounts of information about that coldest theater of the Cold War, where the Soviets tried to hide their missile-carrying subs under the icecaps while the American attack subs tried to track them, ready to destroy them if the war turned hot.

Now the Cold War is over and the Soviet Union belongs in Davy Jones' locker and this classified information is being gradually released. Scientists are ecstatic at how all this might add to our understanding of the environment, geology, climatology, weather forecasting, pollution, marine engineering, and mineral exploration.

Incidentally, a summary of what may be revealed in this long-hidden treasure can be found in the report this summer of the Medea Group, a team of some sixty scientists from the academy and industry who advise the nation's intelligence agencies on how secret data can be used to study the environment. You can get a copy of the Medea Report by voice request at (703) 883-5265, or by fax (703) 883-6190.

I got those numbers from the *New York Times*, where I have always gotten much of my top secret information—even when I was White House press secretary. No kidding. In the mid-sixties I once asked the Pentagon press office to send over clippings from newspapers around the country reporting on a certain defense policy. A few days later I received several cartons of clippings and every carton—all containing only published clippings—was marked **TOP SECRET!**

But as I said, this is a subject I leave to our specialists. The hidden secrets of the sea are not my expertise. President Crook asked me, rather, to reflect in these minutes of prelude not on the mysteries that lie in the ocean's depth, but on the mysteries the sea has left in all of us. He said, "*Talk about The Ocean Within.*" And I will.

Perhaps you saw at the museum last evening that exhibit marked "Secrets in Concretions." A concretion is a crust of shells, coral, and minerals formed around metal objects in the sea. They look like a rocky mass. But the shape of the concretion doesn't always betray what it contains. Only x-rays can do that, and if you pushed the button on the exhibit, as I did, a rear panel lighted up to reveal an x-ray which clearly showed the iron objects embedded in the concretion. I understood at that moment precisely what Bill had in mind when he said, "*Talk about The Ocean Within.*"

Our lives are concretions. And deep within us are metaphors and images, memories and visions, deposited there through the millennia by the power of the sea acting on the human imagination. They have shaped our personal

and collective responsiveness to the world as surely as the seismic shifts of tectonic plates rebound on distant shores.

I was a landlubber. The insular world that nurtured me was bound north and east by the Red River, and to the south was the Sabine. The only ocean I knew for twenty-one years was the sea of blue horizon that opened above Highway 80 as we left the piney woods of East Texas and headed west toward the skyline of Dallas which soon appeared in the distance like the mast of a mighty-sheeted schooner.

A landlubber—no question about it. And yet even in landlocked East Texas we understood that “they that go down to the sea in ships, that do business in great waters, these see the works of the Lord, and his wonders in the deep.” Now, my only exposure to watery depths was the baptismal pool of the Central Baptist Church, but I knew from Job that “God maketh the deep to boil like a pot.” And Isaiah laid upon us the “burden of the desert of the sea.” And with the Preacher of Ecclesiastes we pondered how “all the rivers run into the sea, and the sea is not full.” And no one who heard our own Newman McLarry preach doubted that upon the arrival of “the new heaven and the new earth” the sea would “give up the dead which were in it.”

Miss Selma and Mrs. Hughes made it possible for even high school seniors to see with Byron “the tender azure of the unruffled deep” and with Walt Whitman to imagine no stranger miracles than “the fishes that swim . . . the motion of the waves . . . and ships with men in them.” When Inez Hughes read “Thanatopsis” I swear we shivered at those “eternal whisperings around desolate shores.” And such ancient echoes reverberated from *Childe Harold*:

Dark-heaving—boundless, endless and sublime—
The image of eternity—the throne of the invisible;
Even from out of thy slime the monsters of the deep are made . . .

So quietly and unseen, as the oyster spins the pearl, the imagination formed. In my mind’s eye I can still see the melancholy but charismatic woman who took Milton from her parlor shelf and introduced innocents from Tulia, Dripping Springs, and Nacogdoches to the “wild and wounded waters” of *Paradise Lost*:

Before their eyes in sudden view appear
the secrets of the hoary deep, a dark
Illimitable Ocean, without bound,
Without dimension, where length, breadth, and height,
And time and place are lost . . .

She had come home one afternoon, then a much younger woman, to find her husband, the father of their twins, dead at the bottom of the well. And

turning to Edwin Markham she recognized in herself what he saw in the sea:

She knows all sights and she knows all sinning,
And they whisper out in her breaking wave;
She has known it all since the far beginning,
Since the grief of that first grave.
She shakes the heart with her stars and thunder
And her soft low word when the winds are late.
For the Sea is Woman, the Sea is Wonder —
Her other name is Fate.

How is it that in the dust of Denton County, in the crustaceous insularity of a life far from the rising and falling tides, the gifts of the sea find hospitality?

How is it we own the sea which in turns owns us?

Perhaps it is that in the unconscious, embedded like the oxidizing iron within the ocean's own concretion, are primal memories of that phantasmagorical Deluge spun by storytellers of many cultures through time. For it is true that deep calls to deep, and the sound of the sea resonates in you and me. After all,

The hollow sea shell, which for years hath stood
On dusty shelves,
When held against the ear
Proclaims its stormy parent, and we hear
The faint, far murmur of the breaking flood.
We hear the sea. The sea? It is the blood
In our own veins, impetuous and near.

Perhaps.

Now to our first specimen. She comes from the Scripps Institution of Oceanography. It was founded in 1902, somewhat before Mary got there. But since her arrival in 1992, she has added so richly to its honored and venerable reputation. If you read the summary of her remarkable accomplishments in your program, you will understand why I am so honored to introduce Mary Altalo.

THE OCEAN: ENGINE ROOM OF THE PLANET

MARY ALTALO

It's truly an honor for me to be here. I am in awe in many cases of my distinguished co-panelists. Bill, I am very glad that you don't know anything about the sea in that when I make mistakes you won't be able to correct me.

Bill Moyers: Oh, I will anyway.

Mary Altalo: Please do. In meeting many of you last night and speaking with many of you at that lovely reception, I realized that there is such a general interest in the sea as Bill has said. And what I would like to share with you is my vision, my experience, my feeling of the sea and how the ocean is a critical player in our universe, in our earth system.

When I think of the sea (I guess the sea is in my blood, or water is in my blood as I was born and raised in Michigan around the Great Lakes) I remember as a child listening to my grandfather—he used to be a first mate on a freighter—telling me stories about the sea. My grandmother would not marry the man until he had quit the sea, but he procrastinated until he was 40 and then finally quit to marry my grandmother.

What I am finding more and more as I explore my interests in the sea is that I can't talk about the sea unless I talk about the atmosphere and I talk about the geosphere—the earth. They are linked and it is impossible to pull them apart. I am continually struck by the similarities in the ocean and the atmosphere and the geosphere.

When I first came to Scripps, one of my first jobs was to attend a conference in Los Alamos, and the topic of that particular conference was atmospheric modeling. Now, I am a biological oceanographer. I work with microscopic plankton, red tides. They are the food source for things like whales and fish. What am I going to say and what am I going to contribute at an atmospheric modeling conference?

But as I sat and looked at the slides and I looked at the view graphs and I started to recognize that many of the problems, many of the patterns, many of the cycles which we see in the atmosphere, in the clouds, in the changes of the earth, we see in my planktonic organisms. I saw the same patterns, and, actually, I was delighted because I could actually ask questions, and that's what it is all about. That's what getting to know anything is—understanding it enough to ask questions.

The other fundamental understanding I had was for my own phytoplankton and how they grew and how they formed patches and how they formed "clouds" and red tides in the ocean. I could see similar patterns in the cloud formations in the atmosphere. We were all, in many cases, at the same stage of our problem solving. We all needed finer and finer observation systems—new tools. Man is the ultimate tool maker, as well as tool user.

And we have all this wonderful technology now at our disposal which we can utilize and combine and integrate to really study the atmosphere, the ocean, and the earth simultaneously. We get a lot of our data in real time, and this is extremely important to things like prediction.

As an undergraduate when I was at Smith, hypotheses about the tectonic processes and sea-floor spreading were coming about (I know Bob will tell us a lot more about the geology). And I can remember feeling at that particular time that Earth was this dynamic rotating place, and the physical earth was a rotating process.

Some of my earliest work was in estuaries, and in an estuary, or a small embayment, you cannot study the oceanography, you cannot study the water without studying the atmosphere, the effects of the winds, the effects of the day/night cycle, the effects of the thermal warming and cooling on the surface waters. And you cannot study them without the effects of the resuspension of the sediment, without the effects of the bottom, the changes in topography causing upwellings and downwellings. It's impossible. So my feeling is I was blessed in being able to start out with research in estuaries because it gave me the unifying concepts that I see in the ocean, the atmosphere, and on land.

The other aspect, because I am trained as an ecologist, I think I am trained to see connections, to see patterns, to see webs and interactions. And I can remember realizing in an introductory ecology course, for which there was a textbook written as *Energy Flow in Biology*, that these patterns and connections are really nothing more than energy flow. You put energy in a system and it organizes that system. And that's what I want to talk to you about today.

I call this talk the Engine Room of the Planet. Why? My visions of engine rooms. I used to spend about one hundred days a year at sea before my twins were born, and they've kept me busy at home now. But I can remember going down in the bowels of some of the coastal vessels, and what your first impressions and your first feelings are—the vibrations, the heat, the smells, and the noise that you hear. You know something critical is going on in an engine room. And the earth has an engine room, and that engine room, I believe, is the ocean.

There are gears and belts and pulleys, valves, thermostats, levers. They transform energy into motion, transform different types of energy into motion. There is a fuel, as a fossil fuel is, as well as the fuel of the sun. There are cooling systems, there are gaskets, air filters, strain gauges, and releases. And through this talk, I'll try to give you a feeling that a lot of what we see going on in the ocean is very similar to the types of things we do see in an engine.

What I want to talk about is how energy organizes our system. And so what we're going to do is we're going to start with the energy sources of the earth. There are two energy sources for our earth. We've got the sun, the fusion reactor, which is providing energy to the earth. But you've got

another source of energy to the earth, which is extremely important. That's its internal source, its internal core. And the difference is that the core is formed and the energy sources of the core are formed really by three major processes—crystallization, isotopic decay, and gravitation. Again, for an ocean, there are two different energy sources that are impacting it.

And when you take these energy sources and you put them into the ocean, or you put them into the water, they will tend to organize the system. What you wind up having is differential motion and cycling. You have cycles that occur within cycles. You have similar patterns of motion in the earth, the atmosphere, and the ocean. And these phases are all interconnected.

When you look at Earth from outer space, the very first thing you see is motion. You see cycles, you see eddies, you see the clouds, which are actually tracers for a lot of the currents that are going on. There is movement going on. There is a lot of cycling. And the atmosphere is the halo around this glow which allows our energy to be accumulated.

That particular process of accumulation is extremely important. If we look at the sun and we look at the moon, the sun will impinge upon the earth as well as the moon. They are about the same distance from the sun. But the actual temperature of the surface of the moon is zero, whereas the earth is about 57 degrees, and that is really due to the atmosphere. It acts as a natural greenhouse effect.

The composition of the atmosphere is extremely important. We have carbon dioxide, carbon monoxide, methane, water vapor, and these are the types of gases which actually trap the heat. So the composition of the atmosphere around the earth is very important.

Greenhouse gases which trap a lot of this energy, a lot of this atmosphere, are not the predominant ones. Nitrogen and oxygen are. Now, oxygen has evolved significantly over time. And millions of years ago, the first oxygen was produced in the water by a lot of the bacteria. They produced oxygen, which became released out of the ocean into the atmosphere. But what happened? It didn't stay there.

This was at the time when the earth was forming. And you have these crusts being pushed up through the water. A lot of the crust was iron. What happens when you put iron and oxygen together? It rusts. So the very first thing that this released oxygen that came out of the water into the atmosphere did, it didn't stay there. It rusted everything on the planet. And only after the planet was totally rusted was oxygen then allowed to increase in the particular atmosphere, allowing our planet to warm.

And once our planet could warm, and once there was enough oxygen in the outer area to get rid of the UV radiation, then the organisms could crawl out, out of the ocean onto the rusted land. Before that, they couldn't go out

because of the UV, and the only way to escape that UV was from the surface waters.

The next thing I want to talk about is how the atmosphere is organized. And let me give you a little bit of idea of this atmosphere and the dimensions of it. Mount Everest, if you look in the center diagram, is about a little less than about 8 or 9 kilometers tall, and most of the clouds are in this area. And if you look at the altitude of the left side—I have it in a logarithmic scale. Closest to Earth is about 10 kilometers out, and this is the troposphere, and then 100 kilometers, and then the farthest layer we have, in the 1,000 kilometer range. Most of the action is in the area very, very close to the planet. And, again, this is greatly expanded.

But there are some interesting concepts that are occurring here. For example, if you look at the temperature near the planet, we have a very nice environment. As you go up, it gets colder. But you go up a little bit further, it starts getting warmer again. Why? Again, because of this greenhouse effect. So there's a temperature difference as you go up through the atmosphere.

And what we have is we have a series of temperature gradients, temperature differential, which cause a lot of circulation. And it's the circulation which I really want to tell you about next.

I told you the concentration of oxygen was changing in the atmosphere. A number of years ago, some interesting stories started to accumulate of what is going on with carbon, and many of you have seen this diagram. These are multiple-decade concentrations of carbon dioxide in the atmosphere, which were taken from the island of Maui at an observing station. And over the time periods it has gone up significantly. And this has caused great concern, great alarm, about a significant warming of the atmosphere.

The second change in the atmosphere is the apparent influx or change in the distribution of ozone around our planet. Now, ozone, as I had mentioned, is the major factor which is causing the UV to be absorbed. And as the ozone is decreasing the UV is increasing and coming in. And these are extremely important concerns for our time period.

If we look at the circulation of the atmosphere we see it is dynamic. The heat from the equator is rising up into the higher portions of the atmosphere and being transported poleward. It gets cooled and it sinks. The atmosphere, therefore, is a dynamic circulating system which allows transport of dust, water vapor, microscopic organisms, viruses. Something extremely interesting that's being looked at more and more carefully today is the airborne transmission of disease, as well as waterborne transmission of disease. But the whole atmosphere is a cycling process.

One of the wonderful things that our tools have been able to produce is

not only the ability to observe, such as using satellites to observe clouds, but a lot of computer modeling and computer simulation as well. And what we have here is a reconstruction of the cloud layers over the western United States using computer models. These are allowing us to predict movements, to look at the various layers of ice, snow, ice crystals, and rain at various levels within the clouds, and allow us to understand how the water vapor is truly cycling throughout the system.

One of the other uses of models, in combination with satellite observations, is in showing us now is that the actual UV dosage to the surface of the world—the ocean, as well as the land—is determined not only by the thickness of the ozone layer, but depends upon the clouds and the cloud thickness. These are the kinds of models that are being put together. This is actually the dose rate of UVB to the surface using the ozone models, as well as the cloud models.

What this translates into is, if you can take a model of what UV you will need to cause damage in plants or skin cancer in animals, you can calculate what areas of the world, based on the predictions of the changes in ozone and the predictions of the changes in the cloud layers, will be most affected and most prone to damage. This happens to be the plant dosage rate. This happens to be areas which will be most susceptible to the skin cancer dose rate.

I want to keep coming down a little bit more and getting into the surface. One of the things that Bill alluded to was some of this new reclassification of data from the Navy. And I want to show you one of the diagrams that has been put together using some of the new bathymetry which the Navy has released, along with some of the other satellite data that has been collected in the past.

The amount of effort to get a total ocean benthic map is tremendous. And what we have here is a method of using satellite data to get rid of the water essentially and look at the benthic topography of the ocean. We have the bottom of the container of the ocean now as transparent. We can see what's going on at the bottom. We can see how the ridges are formed and plates are shifting, et cetera. And this is all done through a series of satellite measurements using ocean surface topography.

So we've got the bottom of the ocean mapped. Now we need the top. And we're going to another satellite, and a different algorithm, and a little bit different processing. And now we're going to look at the top of the container—the top of the oceans. And this is the dynamic topography, the upper bounds of the ocean. And one of the things that has come out, and which is exciting, is that the upper bounds of this ocean follows very, very closely the benthic topography of the ocean.

I told you that the atmosphere is cycling. Well, the winds at the surface are also driving the ocean's cycling, and the ocean is cycling in a conveyor-belt motion. Surface waters, which are formed at the equator, are warmer. They float on the surface. And if we start looking at the Atlantic, we're finding that they come to the surface, they are transported poleward. Once they get into the pole areas, they cool off, they sink, they follow the water, the topography at the base, they circulate between all oceans. There is a huge conveyor belt around this planet which is taking the waters, and what's in the water, which is extremely important, through all sections of the ocean.

How are we going to measure these types of water masses? We see these water masses flowing. We see them transferring between different ocean basins. But there's a series of new technology, there are floats, there are drifters which you can actually put in water masses and follow them. And for deep currents, this very often takes a matter of years and years, sometimes decades, to be able to follow these water masses. But these are critical to the formation of the circulation.

There are other ways of measuring basin scale changes. This happens to be a diagram of an acoustic array, using sound in the ocean to measure whether the ocean is warming over a period of time. The speed sound travels in the ocean is proportional to the temperature. If it is warming, the sound will travel faster. If it's cooling, it will travel slower. So the idea is to use arrays of acoustics to try to measure the warming or the cooling of oceans in various locations.

There are other elements that come from the bottom that are extremely important in tagging water masses so that we can trace them. This happens to be from the east Pacific rise—benthic suspensions of helium. We can trace these because we have a point source, and we know the initial concentration. We, therefore, can trace these water masses.

Now, I want to tell you a little bit about clouds. This is again one of those stories that has just recently come to light. There is a really strong feedback between the atmosphere and the oceans, and it is particularly prominent in the western Pacific in the area around Fiji, a convenient place to work, I must add.

There's a warm pool of water where on the equator we're getting a tremendous amount of sun, solar radiation, in this area. And we're pushing it into the water. And the water's getting hotter, and it's getting hotter. But it never ever goes above a certain temperature because as soon as it reaches that temperature, it starts to evaporate. There are vigorous exchange processes, clouds forming here. As the clouds form, they provide layers which protect the sun from impinging any more on that surface layer, and, therefore, forms a very, very effective thermostat.

Verification of this thermostat hypothesis has been carried out over the last few years, and we conduct campaigns—oceanographers, hundreds of oceanographers—to work on this. We have aircraft surveillance, we have buoys, we have multiple ships, we have drifters, we have water-mass dye tracers, and we have satellites all trying to follow this dynamic process.

Models are extremely important. We now have models of the ocean and we have models of the atmosphere. We can simulate. For example, the atmosphere models are so good now that we can ask questions like this. If the CO₂ in the atmosphere doubles over the next number of years, what are the areas that are most prone to increased heating? Those are the kinds of questions that these atmospheric models and simulations can ask and we can answer.

The global ocean models are extremely good, too. But the thing that is the most critical now is the coupled models. There are now models which show the interactions between the ocean and the atmosphere.

I'm going to tell you a story. The story's about El Niño. And most of you have heard the El Niño story. In many cases, we know that when El Niño comes, there is usually a lot of rain in certain areas, but in particular along certain coasts. But let's talk a little bit about what this is.

El Niño actually starts again in the area off Australia, in the Fiji area. And this warm pool that I talked about starts to migrate. The warm pool actually starts to migrate across the ocean. It goes from west to east. It goes towards our particular continent. And as it does that, and this is a slice through the ocean at that time—this warm pool, which is usually confined or stuck on the western side of the Pacific, starts to travel all the way across the Pacific. But do you remember the clouds that are released, those clouds that are interactive over that warm pool? Guess what? They come with it.

As this warm pool starts to migrate across the ocean, more and more precipitation falls on coasts that never usually have it. This is one of my favorite breakfast areas in La Jolla during an El Niño many years ago. It's called the Marine Room, and you can see that in certain time periods the surf height dramatically changes.

Ocean and atmosphere interactions—a very tough place to study. Again, mankind is the toolmaker. We've made all kinds of vessels to study different things. But some of the things we most want to study occur during storm events. The higher the sea state and the stronger the winds, that's when we want to study ocean atmospheric interactions.

It's a tough thing to do on a ship. So we have built unusual vessels. This is called Flip. This actually is a platform that, when we take it out and we put it on station, we fill up one end of it, we ballast it, it tilts, tilts up, we extend our instrumentation, and it becomes a floating spar buoy, which is 300 feet in length. How wonderful. A hundred feet above the water, 200 feet

below. It is very stable, as you can imagine. You finally have a platform that you can study air-sea interaction from without getting tossed around and bounced around—a wonderful, wonderful invention.

There are other types of instrumentation, along with the observations that are critical if we're truly to study these kinds of interactions. When we do have multiple ship campaigns and multiple ship expeditions, we will cycle and circle around Flip with some of the larger vessels as well to be able to get the exchange rates between the atmosphere and the ocean.

What I want to talk about next is what's contained in the ocean. And I'm going to talk about something near and dear to my heart, the little solar cells in the ocean. What captures the sun energy? What captures this heat energy? This is all captured by individual tiny planktonic cells. They're little solar collectors. That's all they are. They happen to be different colors because there are different colors of sunlight that come in, and each one has its own way of capturing light energy.

And what this slide shows are observations from satellite of areas which are prone to high concentrations of blue organisms, or phytoplankton. What this means is there's a lot of photosynthesis going on. So there's a lot of oxygen being released.

This is a satellite view of the east coast of the United States. You can see Cape Cod in the mid-left quadrant. You can see Long Island Sound. You can just see at the very left side the Chesapeake Bay and the Delaware Bay coming in. On the top are the patterns of phytoplankton distributions. Again, this is where all the action is coming from. This is where all the photosynthesis is occurring and the energy is transferring. And the bottom picture is the sea surface temperature at the same time. Our satellites as our tools are bringing us all this information.

Satellites are pretty accurate. We can use them on smaller and smaller scales. This happens to be the Chesapeake Bay. And if you'll look on the very left side, that's the Potomac River. There is a major spot in there of green. This is a very, very strong accumulation of plankton only a few kilometers long. Now, we're seeing this from a satellite! And we can also see the upstream and downstream migration of this over a satellite time series. So we've got the tools to do the jobs adequately.

If you take a vertical slice through this area, we see that a lot of things which are in the surface are actually also transported on a conveyor belt, only a small conveyor belt, down into the sediments. So that if you look now at a surface slice of the sediment, you see that things can be deposited—carbon can be deposited.

This is the culprit right here. This is the individual little phytoplankton solar cell. But look at it. It is covered with pores—things to exchange nutrients. And what you've got, essentially, is a bag which contains

atmosphere; it contains water; and it contains rocks for nutrients. That's what this phytoplankton cell is doing. And there are connections which keep the organisms in contact with the water. Their sole job is to put together the two media. The cells often reproduce at a doubling rate of about once per day. They're highly pigmented. These structures are the little solar collectors. They have chloroplasts, which capture the sunlight, and they form the major thrust for the food chain—the major basis for the food chain in the ocean.

Now I'm going to go to the third cycle, and that's the cycle within the earth—within the geosphere. And, again, we realize that recent examinations have shown that the crust is very uneven. And if we look at a slice throughout the core of the geosphere, we also see that there is a lot of convection. There's a cycling, very much as we saw and very reminiscent of what actually occurs in the ocean.

A lot of the material which is formed at the surface is also being thrust downward. Evidence of the thrust?—things like earthquakes—as the crust is moving. There's also a lot of evidence of things being brought up to the surface as well, and these have to do with hydrothermal vents.

There have been a number of expeditions conducted over many, many years which have actually enabled us to look at some of these cycling processes, and how they relate to the composition of the particles in the air. These are the sites of the deep-sea drilling projects. These are the number of bore holes over the last decade that have been drilled around the world to get a map like we see.

People don't realize when they see these composites, the hundreds and thousands of hours that were necessary in order to get a lot of these measurements and put the composites together—work on ships like the drilling ship, which has actually been able to take pieces or plugs out of the bottom of the ocean and analyze them. These efforts have been going on for years and years.

Studies of the hydrothermal vent communities started a few decades ago, with the first discoveries that the heat generated at the bottom of the ocean could actually support life. More and more in areas of activity, we're finding all different kinds of communities at the bottom of the ocean. It is not sterile. It's very diverse. And these communities live off a non-solar energy source.

There are also entire communities—this happens to be from a hot source. There are also communities that are found in all of Mexico which are living off a cold energy source. These are the hydrocarbon sources and the methane seeps that are in the Gulf of Mexico. They support communities as well.

One of the things that I wanted to end with is another interesting concept.

Again, I'm going to go back to clouds. The life span of clouds is from minutes to hours, and they produce heat and condensation. They process air. I'm going to use the same concept for clouds of phytoplankton where the life span is from hours to usually months. They also produce heat. But they process water, not air. It's an extremely important vision to try to look at.

I'll leave you with a number of thoughts. Every time you go out and you look up and you see clouds, realize that they're part of the ocean that you are looking at. When you look up, you'll see the changes, watch these clouds. You're going to learn a tremendous amount about the ocean and about the earth. Look at their cycles. Look at their formation. Look at their dissipation. Realize that the only thing that's suspended in a cloud is what can be supported by the air. But the same principles exist on many different levels. Thank you.

Bill Moyers: I have two quick questions, Mary. What would you say to the French writer, Madame Anne-Louise de Staël, who says in her novel *Corinne* that the sea appears today as it did the first day of creation?

Mary Altalo: Well, they say she's quite old. I think that's interesting. First of all, if she sees what I see in it, then she perhaps is right. She sees processes. She sees patterns. She sees things that are existing in time and space—constant change. She sees that it is evolving. But I would have to disagree with her as well. And I think we have to realize that a lot of what we see in the sea today is because we are here. We exist. And we have a lot of interplay, particularly in the coastal regions, with the sea. And what we see in the bay here, what we see in a lot of the estuaries, what we see in the coastal region, is a direct effect of what we actually have put into the water, what we put in from the land and from the anthropogenic inputs—from man—and their activities.

Bill Moyers: You describe such a dazzling consistency of change that I'm wondering if you find it conceivable that the oceans could be so changed that human life would be profoundly affected.

Mary Altalo: Yes, I do. I think one thing of concern is happening right now, with the story about the rising of the heat and the trapping of heat by the atmosphere—I showed you the circulation, I showed you that conveyor belt in the oceans. It is critical to life that that conveyor belt functions. The conveyor belt is temperature regulated. You keep warming the atmosphere. You keep warming that surface layer of the oceans. You are going to change that conveyor belt—no question. You're either going to stop it,

you're going to invert it, you're going to change where it arises, where it comes to the surface and where it goes back down. Yes, I do see that we could have a major, major problem.

Bill Moyers: Some response from your colleagues to your other side.

Question: Mary, I would think that some people in the audience might be interested in the impact of El Niño we've seen so much about in recent years. Now, we seem to see that it's affecting things for years at a time here in Texas. Could you give us your ideas about how it's affecting us here in Texas—kind of a time frame?

Mary Altalo: Yes. In fact, one of the things that I think is extremely important, and one of the hot topics in El Niño research, is how would what you see in Fiji and in the western Pacific and these cycles—how would that be translated to other areas of the globe? There are what is called teleconnections, and these teleconnections are that we can see this warm pool moving across the Pacific. As it's coming closer and closer to the West Coast area, what happens is that it spins off. It spins off little webs, little connections, such that it impacts greatly the rainfall over the entire United States. In fact, a lot of the floods in Mississippi have been possibly attributed to, or have been connected with, or there are efforts to try to link them to these El Niño connections. And what we're seeing in various areas are the results of these threads or these teleconnections. That's where the hot area of research is going on right now. And this is what we're trying to find out. It is also the sociological impact which is important.

Question: What do you mean?

Mary Altalo: Sociological impact in that in areas where there is a flood or where there is a drought, you may have great ecological damage, agricultural impact in particular. So, for example, if you know 18 months in advance that an El Niño is coming, and you know it's going to hit your area, and you know your area is going to be, say, very rainy, you're going to change how you plant. You're going to plant flood-resistant seed or you're going to change your planting areas. If you know your area's going to be impacted and it's going to be drought, you're going to put drought-resistant seed in.

There are all kinds of economic and sociological impacts from El Niño which we're just beginning to find out. And they are crucial to our understanding.

Robert Ballard: Mary, before you went to Scripps you spent a lot of time on that small community on the shores of the Potomac surrounded on four

sides by reality. And I was just curious, as you have left the Washington scene and now entered Scripps, how do you see the impact of the changing philosophy in America about investing in long-term things like research? What's the prognosis of the changing atmosphere—politics in America—to our studies of the oceans?

Mary Altalo: Bob, you've hit a lot of very important questions. One of the things that had to be translated to the policymakers was the importance of continuity of research, and this has only occurred over the past four or five years. Very often congressional funding for particular programs, or even agency funding for particular programs, was going to be for a three-to-five-year cycle. And if you're studying something that's going to have a decadal to century time-scale cycle, stopping a few years into the research isn't going to do any good.

I see a lot of the agencies—the agencies in particular are picking up that there needs to be continuity in the research. We do have a problem with the intergenerational program with Congress in that every time there is an election, there is a questioning and there has to be a recommitment to these long-term processes. It's a slow struggle. It is a very, very important one.

Bill Moyers: Can you give us an example of the importance of continuity in research as one concrete image or problem or policy?

Mary Altalo: Problem or policy?

Bill Moyers: I mean, some example of why it makes a difference if you interrupt research after a period of time.

Mary Altalo: Okay. Let me take a—for example, we have a time series at Scripps which is a seventy-year time series. And it has daily measurements from the pier of temperature, salinity, some of the phytoplankton counts, solar radiation, et cetera. Through utilizing these kinds of time series, if they are interrupted, you will never be able to really look at the trends.

One of the things that it's very important to find out is whether what we're seeing is part of a major trend or part of a natural variability of the system? That's what we're really trying to get at.

Robert Ballard: Another example. It's very popular when you go in the field, and there's a lot of publicity commonly associated with field programs. Ships go out, satellites are launched, submarines dive. But the field program is the collection of the data. It's very common to lose interest after the field program is over. It takes many, many, many years to analyze what you did.

And, unfortunately, that tends to not be popular to a lot of sponsoring agencies. They want you back in the field. But there's a lot we can learn from what we've already done.

Bill Moyers: Bob, is Washington the only source of the kind of funding necessary for the continuity of research that you and Mary both are talking about? Are there not other sources—foundations, industry?

Robert Ballard: I'm presently moving into a field involving the social sciences that is mostly privately sponsored. But fundamental basic research is really an investment by a society. And industry has not played a significant role in what we call blue water oceanography, the vast majority of our planet that's on the high seas. It's been the federal government that has invested in the future generations.

Tony Amos: From my own field of research, which does involve some fairly long-term measurements, one of the questions I always get asked by the public is, "Is it getting any better or is it getting any worse?" And the only way to answer these kinds of questions is to do some comparatively long-term measurements.

I'll give you just a small example. I have been working on the local beach here, and one of the things that I measure, for example, is the health of the bird population. And there is a bird that winters here. It's called the piping plover. It's on the endangered species list. Had I stopped my survey after about, say, five or six years, I would have concluded that the population of the piping plover was going downhill. As it happened—I've been doing it now for eighteen years—I have seen a trend that has now brought the population of that particular bird uphill.

It's an awkward question to answer in that you have to see several cycles of some phenomenon that may not be compatible with the funding cycles, that's for sure. There are some programs (long-term ecological research programs, or LTER, for example), which, unfortunately, I believe, are somewhat threatened by the new feeling in Congress. Some of these programs that are funded by agencies which may not be continued. And that is a great shame.

The time series on the Scripps pier is, I think, a prime example of how, by dint of just a few individuals' incredible effort, a wonderful time series of information is being collected.

Bill Moyers: Tony, you mentioned that one little bird. What's the implication of the discovery that its numbers have increased?

Tony Amos: The implication in this particular case is that there is a

program—what they call “The species recovery program”—for all endangered species, where there is an effort to, in fact, bring them from the brink of extinction. And should one then see the population of the bird (outside of its breeding range, in this case) increasing, you might imply that program has been successful. And I believe it has in this case.

Barto Arnold: I was searching for an area of commonality between the social scientists and my hard-science colleagues here. And Bob hit on the matter of what happens after you get back from the field. And that’s particularly important in archaeology. In my case, if you excavate a shipwreck and are not funded and prepared to preserve the artifacts, they will go straight to hell.

You’ve all seen things come out of the ocean—anchors and cannons in front of restaurants simply crumble away over the years. Wood, in particular, can go overnight. It can be twice as expensive to preserve and study the artifacts from a shipwreck as it is to dig them up, and it can take three or four times as long.

Getting back to the global perspective on the ocean, just one thing, historically, as an anthropologist. The ocean, at least the near-shore ocean, was a friendly corridor of transport in early days. And bear in mind that people got around a lot more than you might think. There were no roads for going long distances very easily on land. But the rivers and the coastal areas were a friendly transport corridor.

Bill Moyers: Any other response prompted by Mary’s presentation?

Tony Amos: One of the things that Mary brought out was the improvement in the methods that we have of looking at the ocean. There’s an incredible increase in our technological abilities in the last, say, twenty years or so. And this is really going to help us in understanding some of these fundamental questions.

I’d like to just give you an example. When I first went to sea in the Antarctic Ocean, we discovered a sea mount. This is an undersea mountain that comes very close to the surface. And as the ship went over the sea mount, and I was on what we call PDR watch, position depth recorder watch, and it was my job (technician as I was at the time) to inform the scientists of what was going on.

Well, the bottom kept coming up and kept coming up and kept coming up. And, in fact, it looked to me, as we were in an uncharted area at that time, that perhaps it was going to endanger the ship. So I even thought it might be the time to inform the ship’s crew that we were perhaps going to run aground.

That didn't happen. But after the chief scientists had a discussion about what to do, whether we should change our course and really investigate this sea mount, we couldn't find it again. We turned around and we could not find this vast undersea mountain because we did not have the navigational technology, and we didn't really have the technology to look at the bottom as we do now. So that sea mount, by the way, is a famous sea mount now. It's call the Eltanin Sea Mount, named after the ship that we were on. Perhaps the Navy knew more about it than we did.

Bill Moyers: I'll give you the fax number for the Medea group very shortly. Before we go to our first coffee break, we have our first question of philosophy from the floor. Liz Carpenter, who was there for the dialogues between Plato and Socrates, wonders why, with all this advance and knowledge and all the new technology of exploration, why she still gets seasick. Can any of you tell her that?

Robert Ballard: Well, I think that the advances that are yet to come will save you from that plight. You'll be able to do exploration from your home on the information highway.

Bill Moyers: We're going to take a break for 30 minutes. First, Bill Crook has an announcement.

William Crook: I asked our last year's president to give me a suggestion that would help me through this year. Our Nobel Prize Laureate, from whom you would expect something profound, said, "Get a louder bell." Well, folks, we have the bell. We hope you'll listen to it and take it seriously. Break off the conversation with the old friend and come back in so we can keep this program on schedule.

William Crook: Before beginning our next session, I want to recognize the 60 percent asset to the Moyers team—Judith Moyers. Judith has her own record of accomplishment and contribution to this country. She served for ten years as the vice chairman of the trustees of the State University of New York, where she raised a storm or two. She serves on the Paine-Webber Board of Directors and on the board of the Ogden Corporation. And she's president of Public Affairs Television.

She's also a member of this group as of last year—she was not able to attend—which is something Bill has not been able to attain. He is a member of the American Philosophical Society, and all they had was Ben Franklin. We had Sam Houston.

Bill Moyers: Thank you, Bill. You remind me that Judith and I were 22

before we saw the sea. We had just graduated from the University of Texas and were heading for a year in Scotland where she was to teach and I was to do graduate study. We went on an eight-day journey from New York to Southampton on a small Dutch ship named the *Ryndam*.

The first day it was a glad unruffled sea that greeted us, the kind of sea that Shelley found "calmed as a cradled child and is slumber bound." But we had been warned that there is no lull like the lull of a treacherous sea. And when that lull passed, we were indeed in touch with Homer's "loud sounding waves" and Byron's "hell of waters where they flow and hiss and boil in endless fortune," and we wound up, both of us, below deck. The whole ocean seemed to flame like an open wound, and we had our first bout with seasickness. It was after that that I decided that I would praise the sea but hug the shore.

I would like to recognize, since she arrived shortly ago, my dear friend and mentor, the First Lady of Marshall, Texas, Ladybird Johnson. Like me, the first whale Mrs. Johnson saw was a catfish from Caddo Lake.

I have to tip our collective hat to Jerry and Cathy Supple who were singing the Sea Chanties during our break. Jerry and Cathy live in San Marcos now, where he is president of Southwest Texas State University. Before that Judith knew them when he was president of the State University of New York at Fredonia, that famous sea-chanting citadel.

Mary, thank you for putting a luminous frame around the opening of this weekend. As I watched your slides and heard you talk, I had a sense of this voracious energy that is pouring forth and back into the oceans.

The public at large is very often unaware of just how enriched our lives are by the steadfast passion of the scientists who understand. But sometimes a scientist breaks through and excites a general enthusiasm about the wonders of a life spent in search.

Robert Ballard is just such a scientist. He comes to us from the Woods Hole Oceanographic Institution, that other great American institution of marine exploration, where he is the tenured senior scientist and director of the Center for Marine Exploration. But I know and admire him as an accomplished practitioner of television, whose work with the BBC, Walter Cronkite, the National Geographic television specials, and Ted Turner's National Geographic Explorer series has captured a large audience for the excitement of science.

His books on his discoveries of the *Titanic* and the sunken German battleship *Bismarck* are worldwide best sellers. But, as Bill Crook was reminding me last night, what is most impressive is the answer that Bob gave to a reporter who asked him, "What were you feeling after you found the *Bismarck*?" And Robert Ballard answered, "What a waste. Will we never learn what a waste war is?" Robert Ballard.

THE OCEAN: WHAT'S DOWN THERE?

ROBERT D. BALLARD

Modern research now suggests that all humans on the face of the earth come from a common ancestry that can be traced back to the plains of eastern Africa, and that during the last 200,000 years our ancestors journeyed forth from their birth place to populate the planet. First across the large Euro-Asian land mass and finally into the new world during the waning years of the Great Ice Age just a few tens of thousands of years ago.

Many factors led to the global expansion of our forefathers, the excitement of exploration, a driving desire to escape oppression, a lust for economic gain or simply in pursuit of a better life for themselves and their loved ones. For whatever the reason, the fact remains our species now dominates the planet, we have all but conquered many of the forces that held us in check for oh so many millennia. Instead of being controlled by the forces of nature, we are now beginning to control nature itself. Our activities have altered the ozone layer, led to a buildup of CO₂ in the atmosphere, begun the destruction of the rain forest, and the continued premature extinction of many plants and animals we once lived in harmony with.

Some demographers now tell us that there are more people alive today than have ever died since our species began to populate the planet, and that number will double again while we struggle through the next century. Despite the rhetoric of the need for population control, we continue to multiply, entering an era where reproduction is now endangering our existence instead of ensuring our survival. During the Rio Convention on the Environment, for example, the impact of global population on the environment was not a major topic of discussion. It is still not a politically correct issue to raise. Perhaps the tombstone of our species will read, "The human race came and went because it was politically correct."

But I am not here to tell you how to control the world's population. Even repressive measures in some countries have failed to accomplish that. I am an undersea explorer from the Woods Hole Oceanographic Institution who would like to talk about man's relationship with the sea and what I think the future holds based upon our continued growth and need for more space.

Despite our globe-trotting abilities, our species has not colonized any new land masses on the planet since the colonization of the new world which began in the fifteenth century. And let us not forget that the new world was already inhabited by our species long before Columbus first arrived in the Bahamas in 1492.

Today the primary activities of our species are still confined to less than twenty percent of the planet, historically held at bay by an aquatic world that resisted our colonizing ways.

Instead of turning to the sea, we turned our eyes and our hearts to the heavens, convinced that if we only tried we could swim in the canals of Mars or grow tomatoes on the surface of Venus. Like superman's race, which, despite its intelligence, destroyed its mother planet of Crypton and escaped to Earth, for many years we have been telling ourselves that we could escape our destruction of the earth and flee into space. Space was a convenient way out—a way we could avoid facing up to the destructive consequences of our unchecked behavior.

To me, however, the most important image to come out of the space program was when an astronaut on his way to the moon trained his cameras back on Earth and captured an image of a very small green-blue planet imbedded in a black velvet void of nothingness.

Mars has no canals to swim in, the atmosphere of Venus is deadly to us, and we can't even land on Jupiter. And, if we could, we lack the muscles in our body to stand up and walk around. Space may be the ultimate last frontier, but with the public's disenchantment in the space program reflected in President Clinton's recent reductions in the Space Station program, we are forced to conclude that Earth is the immediate frontier we must explore.

Ironically, we now have better topographic maps of Venus than Earth. We know more about the physiography of small volcanic cones on the far side of the moon than of similar features in our own exclusive economic zone off America. When President Reagan signed the bill creating the EEZ, the size of America doubled, yet most of this modern-day Louisiana Purchase remains unexplored. And vast expanses of ocean floor in the Southern Hemisphere have never had an oceanographic research ship pass overhead.

The largest single feature on the surface of the planet is the Mid-Ocean Ridge, which runs around earth like the seam of a baseball, covering almost one quarter of the planet's total surface area. Yet, despite its tremendous size and the critical role it plays in the origin of the earth's outer skin, Neil Armstrong walked on the moon and others played golf and drove around in cars there before the first human entered the largest feature on Earth, when they dove to the Mid-Ocean Ridge's great rift valley in 1973.

There are more active volcanoes underwater than on land, great plains that dwarf those in America, canyons far grander than the Grand Canyon, and the mighty Rocky Mountains would fit into a small portion of the Mid-Ocean Ridge.

Given the emergence of advanced robotic technology, fiberoptics, micro-processors, virtual reality, autonomous vehicles, telecommunications, and many other new advances, the ocean is no longer a barrier to human activity. The deep abyss is now our backyard and working at 20,000 feet, which represents 98 percent of the world's oceans, has become routine.

Given our exploding population, given our diminished interest in the promises of the space program, and given the continued development of advanced technology, I truly believe the 21st century will usher in an explosion in human activity in the sea. I am convinced the next generation will explore more of earth, that is the 71 percent that lies underwater, than all previous generations combined.

Just as Lewis and Clark's exploration of the Louisiana Purchase led to the settling of the west, the exploration of the sea will lead to its subsequent colonization. The gathering and hunting of the living resources of the sea, an activity characteristic of primitive societies on land, will be replaced at sea by farming and herding. High-tech barbwire in the form of acoustic, thermal, or other barrier techniques will emerge to control and manage the sea's living resources. The same debates over the destruction of the rain forest's diversity on land in favor of ranching and farming will repeat itself as the great bio-diversity of the barrier reefs of the world are threatened by large-scale farming of the sea.

Oil and gas exploration and exploitation will continue moving into deeper and deeper depths. We have already discovered and mapped oil and gas reserves down to 12,000 feet, which represents the average depth of the ocean, and each year the oil industry brings production wells on line in waters deeper than the previous year.

Underwater parks, memorials, and reserves will expand in size and scope until the *Titanic*, if there is anything left, is easily visited by tourists using teleoperated robots from the comfort of their home-based telecommunications center. When ships and other pieces of human history fall into the deep sea, they enter a deep freeze characterized by eternal darkness, freezing temperatures, and enormous pressures. Some estimate that there is more human history preserved in Davy Jones' locker than all of the museums in the world combined.

During the six centuries that marked the rise and fall of the Roman Empire, Imperial Rome lost more than 10,000 commercial ships in the deep waters of the Tyrrhenian Sea, a small sea off the west coast of Italy. Last year we discovered and explored many of the allied and Japanese ships lost in the cold deep waters of Iron Bottom Sound—ships which still have their camouflage paint clearly visible, their torpedo tubes still loaded, and depth charges resting in their racks—ships with their main guns still pointed at one another as if the battle was still going on.

The Black Sea and its anaerobic bottom water will give up some of the oldest and best-preserved wooden ships in the world, perhaps lost in similar time that Jason and his Argonauts traversed these same waters in search of the Golden Fleece.

On a far less glamorous note, landfills will give way to the placement of waste in the vast abyssal deserts of the deep. Perhaps the storage of nuclear material will follow. We cannot continue to place our waste material in our backyard only to have it pass through the drinking glasses of our children on its gravitational journey to the sea. We continue to hope for solutions to our waste problems, which are not coming fast enough to keep up with our exploding population and the creation of complex waste products.

Our present strategy goes something like this. If we force people to live in their waste, they will think of ways to clean it up. By placing it in the sea, it's out of sight, out of mind, and a solution will not be sought, even if placement in the sea is a wise choice. Present law now forbids us from even the opportunity to find out if it is dangerous to place some of our waste in the deep sea.

Dare we gamble with the lives of the next generation on a prayer and a dream by continuing to pollute our drinking water? Even when you include the heavy taxation on gasoline, high octane at the pump costs less per volume than Perrier and the price of drinking water will only rise, until wine is a cheaper alternative. People are already living in their waste and solutions still elude us.

In recent years, we have discovered major mineral deposits in the deep sea similar to those mined for centuries on the island of Cyprus. They contain high concentrations of copper, lead, and sulfur, as well as silver and gold. And their formation continues today in the vast hydrothermal vent systems of the Mid-Ocean Ridge. These mineral deposits will be processed using the very geothermal energy that drives the crustal processes that lead to their formation. Some of these magnificent vent areas will also become the Yellowstone Parks of the deep sea leading to future arguments over their commercial versus tourist value.

The unique chemosynthetic life forms that presently process the toxic material associated with the vent communities will hopefully be bio-engineered to convert a portion of our waste products into less harmful or even commercially valuable by-products. These exotic creatures will also help us understand the early origin of life on our planet as well as the potential for life on other planets we once ruled out for their lack of friendly nearby sun. Other marine forms will prove to be important players in future pharmaceuticals. We know, for example, that hydrothermal-vent animals process carcinogenic material yet have no tumors.

Whether this all occurs during the next generation's time on earth, time will only tell. But the seeds of all that I have said can already be found in programs presently underway.

Last summer, for example, I traveled to the waters off the Irish coast where the great luxury liner *Lusitania* was sunk by a German U-boat in

1917 helping to precipitate America's entrance into World War I. That expedition, which was sponsored by the National Geographic Society, is just the first step in a long-term program to not only explore this historic shipwreck in hopes of solving a long-standing controversy over its potentially lethal cargo, but also to begin the process of making the *Lusitania* the first in-situ museum on the floor of the ocean accessed from shore-based visitor centers using remotely controlled robots.

But if America hopes to play a leadership role in this brave new future, we must prepare the next generation to meet this challenge. For the last five years, the JASON Foundation, which I helped create, along with EDS and National Geographic, has sought to prepare that generation by taking hundreds of thousands of young students on live voyages of exploration and discovery to the far reaches of our planet. A few months ago, during our exploration of the rain forest and great barrier reef of Belize, more than 400,000 students and 10,000 teachers studied a difficult science curriculum for the opportunity to explore live the beautiful bio-diversity of these unique ecosystems, using satellite downlink sites around the world from which they were also to take control of our exploration robot and operate it from thousands of miles away.

Better understanding the oceans and the land surface beneath it is critical to our understanding of the planet as a whole. For I think of Earth as a live, breathing organism on whose back we live. Yet the collective actions of the human race now threaten Earth's very existence.

The continued growth of our global population is the single most important issue facing our survivability. And although study of the oceans is important, they will not provide the human race with a place to expand. The vast majority of our planet lives in total darkness, in freezing cold water, under tremendous pressure, and covered with featureless mud plains. No human should be sentenced to live there. It would be cruel and unusual punishment to live in the dead sea.

The more I explore the ocean, the more I appreciate that small segment of Earth that is green and sunlit, that small segment our unchecked population growth is rapidly destroying.

The rain forests of the world, which cover over five to eight percent of our planet's surface area, contain 80 percent of all the green vegetation of the continents. Yet we are cutting them down at a rate of 21 million acres a year. In eighty more years they are gone, and so is the tremendous diversity of life that lives there.

Preserving one acre of land in Minnesota is a wonderful act of preservation, but in no way is it equal to protecting one acre of rain forest.

We must wake up to the fact that Earth is a small planet in the heavens and the space upon which we can live is smaller still. So I ask all of you to think about this issue and what steps you can take to save us from ourselves.

First and foremost is the education of the next generation since the actions they take may be the most important actions to be taken in the history of the human race.

Thank you very much.

Bill Moyers: And he finished on time at 11:35. Tell us when the last judgment is coming and we'll be there with you to watch it.

You said that you wanted to leave these human artifacts there because you felt they should be undisturbed as a kind of soliloquy to history. And I'm wondering what the archaeologist would say about that since so much of what the archaeologist can do can only be done with what you bring up from the depths.

Robert Ballard: I made a distinction, a very important distinction, between grave-robbing and archaeology. These are fundamentally different. When you have the engineering drawings of the *Titanic*, when you have all the artifacts you could possibly want from her sister ship, the *Olympic*, this is not an archaeological site. The *Olympic* was meticulously disassembled. All of her finery was collected and is available in museums, and private collections.

There wasn't anything truly to be learned. When I found the *Titanic*, I went to the Smithsonian. I went to the British Museum. And I asked the professionals if there was any value in us recovering anything from the *Titanic*, and they said, No.

But ships of antiquity—pages in human history that are blank—are another story. I have no problem working with archaeologists. There were a lot of blanks to fill in. So that's the distinction I make.

Also, more importantly, when we saw the *Titanic's* bow sitting upright on the bottom, or the *Bismarck*, or *Titanic's* other sister, the *Britannic*—they are all in a high state of preservation.

Britannic is the most beautiful ship I've ever seen on the ocean floor. She is completely intact. Nothing has ever been taken from her, and, fortunately, she's in Greek waters so she's under legal jurisdiction of a contiguous state.

I'm working now with the Greek government and the Liverpool Museum—Maritime Museum to use our technology to make the *Britannic* the first in-situ museum. Let Mother Nature, at no cost, provide the electricity to freeze her and to keep her in a state of suspended animation, accessible electronically.

The *Monitor*, which was sunk off of Hatteras—and the *Arizona* in Pearl Harbor, are other examples of ships that have historical value but not archaeological value and should be left on the bottom.

Guadalcanal is a battlefield that could easily be visited on the information highway in the next decade. Hertz and Avis will begin renting robots on the information highway, and you will visit these places electronically. But if there's a place, if there's a piece of history that we do not understand and do not know about, archaeological excavation is certainly appropriate. In fact, I strongly encourage it.

But the person who's now selling the coal from the *Titanic* is a used-car salesman. With absolutely no history in archaeology, maritime history, oceanography—he has absolutely no credentials. And I would say, as a society, that when you play with human history you should have some credentials.

Barto Arnold: Well, when we started the discussion session, I was sitting in awe of the potential of the deep ocean, archaeologically and historically. The distinction is to be made between fairly modern wrecks and wrecks that are historic sites or grave sites. The *Titanic* should be considered a tomb. And an archaeological site would have more antiquity (than the *Titanic*). There are still people around whose parents died on the *Titanic*, and that requires a different kind of treatment.

Robert Ballard: People who were born are still alive.

Barto Arnold: And the ships that sank in World War II are literally war graves. There are agreements between the countries that they're to be considered war graves and not messed with.

Robert Ballard: So that's a huge difference.

Bill Moyers: Bob, can you give us some measure of the cost of one of these expeditions?

Robert Ballard: Surprisingly, not terribly expensive.

Bill Moyers: You're in Texas, remember. I mean, all things are relative.

Robert Ballard: Well, thanks to the National Geographic Society, thanks to Nova, they invested less than a million dollars in various projects and recouped it all.

Bill Moyers: From?

Robert Ballard: From the video and television specials that they have made

on exploration, and the home distribution of the TV specials. They actually netted a profit. But all the expeditions I've ever done with National Geographic, they've turned a profit. And there's nothing wrong with that.

This last summer's expedition in search of the Roman shipwrecks, the total cost of the expedition was about \$200,000 total cost. So they're not terribly expensive.

Bill Moyers: You hear the murmur from the crowd. I mean, how can it cost so little.

Robert Ballard: First place, with the technology we have, we don't have to stay very long. The whole expedition searching the Roman trade routes lasted ten days. We were able to take advantage of the Navy going over there, using one of their ships. We paid all the costs the Navy incurred, which was mostly gasoline and expendables, and any costs they incurred.

But even our oceanographic ships, the robot Jason, costs about \$5,000 a day to use. And you're working 24 hours a day. That's the important thing. You're on the bottom 24 hours a day round the clock.

It's a powerful technology. We did an expedition recently where we networked all the scientists from shore. They were in their laboratories. So we didn't have to pay to send them out there. We didn't have to pay to have them sit around and wait for their opportunity. We call them up and say, We're ready to do your experiment. We did this in the Sea of Cortez with scientists.

We called up a scientist at the University of Washington, Russ McDuff, and said, Russ, we're ready for your experiment. And we did his experiment in eight hours. He came in on the satellite, worked for eight hours, did his experiment, and went back to work. And we networked other scientists as well.

So the ability to network people and not cause them to have to go out to sea and sit around and wait is the real power of our emerging technology.

Barto Arnold: I would take issue just mildly in terms of cost. Working at sea in oceanography is several times—several orders of magnitude more money than most archaeologists or historians can get their hands on. So, even though the efficiencies are being multiplied tremendously, and I certainly agree with that, most archaeologists and historians don't get their hands on this kind of money.

Robert Ballard: Correct. But most of them don't have to go to 20,000 feet either.

Barto Arnold: That's right.

Robert Ballard: And so it's a question of balance. There's a huge difference between zero and something, and these were the first ships ever discovered in the deep sea. So it isn't like there's a lot of it going on. There's just a few of us.

Bill Moyers: I may have missed it. Did you say that in the cellar of the Black Sea . . .

Robert Ballard: There's no oxygen.

Bill Moyers: I heard that. But do we know yet what the effects of that are? Do you have any pictures?

Robert Ballard: Well, we know the effects of an anaerobic setting in total darkness in cold water. You couldn't ask for a better preserver. The average depth of the central portion of the Black Sea is 7,000 feet. We know that it's been traversed for millenniums. The Greeks went into the Black Sea, much like the Hudson Bay Company into Canada, around 850 B.C. and began to trade with the barbarians. And we know that they lost a good percentage of their ships traversing from the Crimea to the tip of Turkey called Sinop.

No one has ever searched those trade routes ever. It wasn't a friendly place for America until fairly recently. But now we can go in, and I'm very excited about being the first person to explore those trade routes because I think we have the potential of making some really truly fundamental discoveries.

Barto Arnold: Though I think that's right, there are a couple of wrecks from the War of 1812 in the Great Lakes that still have the masts standing and so on.

Robert Ballard: That's fresh water, right.

Barto Arnold: That's fresh water. And in the anaerobic environment, I fully expect to see the masts standing and the ships intact.

Robert Ballard: Sailors draped over their oars.

Barto Arnold: Archaeologists joke about the public having a concept of shipwrecks with the captain lashed to the wheel. Well, you may be finding that coming up pretty soon.

Robert Ballard: I think it's—well it's exciting, and that's what exploration's all about.

Bill Moyers: Until I heard you a moment ago, I never understood the meaning of that poetic reference to old indefatigable. Time's right-hand man—the sea. And I see that the sea is an ally of time there.

Robert Ballard: Very much so. More so than I ever thought, and I think more than any of us ever thought until we began to find human history in the deep.

Bill Moyers: There's a microphone here if any of you would like to move to it and ask a question.

Question: What is the deepest point on the face of the earth? Where is that?

Robert Ballard: It's the Marianas Trench.

Bill Moyers: Where is that?

Robert Ballard: It's off Guam. It's in Challenger Deep. The Marianas Trench—and the spot is called Challenger Deep because it was found by the H.M.S. *Challenger*—is 35,800 feet.

Bill Moyers: How does that compare to the Gulf?

Robert Ballard: A bit deeper. I think the Gulf bottoms out about 15,000.

Tony Amos: 3,900 meters.

Robert Ballard: Yes, so 10,000. So it's one-third.

Steve Harrigan: I'd like to ask Robert Ballard and Mary Altalo the same question concerning potential unknown creatures. In this century, we discovered—or somebody's discovered the sea coelacanth or rediscovered this fish that was thought to be extinct off the Indian Ocean. In the last decade, the megamouth shark was discovered. As far as I know, no one had ever known about him before.

What about in the bottom of this great trench where life is being created in these thermophilic organisms. Where do you speculate that food chain ends up? Is there, you know, an abominable snowman down there in these underwater mountain ranges?

Robert Ballard: Mary? She's the biologist.

Mary Altalo: Yes, but he knows about the deep sea organisms.

Robert Ballard: Well, we'll do it together. You first.

Mary Altalo: The food-chain dynamics is a very, very interesting question. And, again, it's one of those things that we have to keep going back to try to put the pieces of the puzzle together. It's very difficult to speculate, and I think what we're finding, too, is that various localities and the various regions, because they have such different populations, very often you can't totally extrapolate between the food-chain dynamics of one area and another. I really can't speculate on the top grazer, so to speak.

Robert Ballard: The fascinating thing about hydrothermal vent systems is that they occur in very primitive volcanic terrain. In fact, most of us now are recommending that when future probes go to Mars, go inside the lava tubes and look around. Don't look on the surface. What's wonderful about the ocean is, because it's fluid it has an incredible coupling capability. It does it acoustically, but it does it chemically. Lobsters are able to send out a scent when the female is ready to reproduce. And this is sent off into the water.

You could have an extremely sophisticated life-driven chemical system that we can't even think of right now that could be existing in that trench. It's certainly been around a long time. It's been around billions of years.

Wes Tunnell: Part of my training is in malacology. That's not malecology, bad ecology. It is the study of the phylum Mollusca, the shells of the sea. And one of the areas of study, the cephalopods, show us the largest invertebrates to go to this giant size we may be thinking about. The largest cephalopod that is known is the giant squid that lives in the deep sea, and the largest one of record is about 60 feet in length. The body is 12 of those feet, and the tentacles or arms are 48 feet.

The whalers have noted that the giant squid will leave scars from the suckers that they hold onto—sounds kind of Jules Verne's here, doesn't it—onto the side of the sperm whale which feeds upon the giant squid. Whalers tell us that they have found scars that are 9 inches in diameter on the sperm whale. So can we multiply it by three and assume that there are 180 foot squid, or invertebrates, out there? Jules Verne might have been right.

Robert Ballard: I also understand their growth is tied to El Niño, the absence of it. They're basically food-chain driven—that is, they grow to large dimensions if the food's available and don't otherwise.

Steven Weinberg: I wanted to ask Robert Ballard what happened to the guns on the *Bismarck*? They seem to be missing.

Robert Ballard: The guns on the *Bismarck*, her four main guns, Anton, Bruno, Caesar, and Dora, were gravity seated. And when she scuttled herself, she uniformly flooded all her compartments, and, as a result, she rolled over instead of pitched down like *Titanic*. The last time everyone saw her, she was completely upside down. At that moment, they fell free—they fell out of their gravity seats. We found them on the bottom upside down.

But then on the way down after the scuttling holes flooded out all the air and she was fully flooded, she remembered her bottom was heavy, and she rolled back and landed upright.

William Levin: I'd like to ask Robert Ballard what is the genesis of the anaerobic environment of the Black Sea, and are there other seas that are anaerobic?

Robert Ballard: Well, the Black Sea is a very unique body of sea. Think of it in the form of a bath tub. It's very much like a bath tub. It falls off very quickly off the coast of Turkey. You're in very deep water within a few miles. Think of a bath tub with an overflow valve where the water only gets out when you fill it too high and it floods out the top. It doesn't have a main plug you can pull out. So the water can only get out of the Black Sea along the top.

The Black Sea is saline. It's a salt-water body of water. The water coming into it is fresh water from the rivers of Eurasia. So you have a fresh body of water coming onto a saline body of water. The fresh water floats in the top of it. It only drains at a 90-foot sill.

More importantly, the rate of influx of water into the Black Sea is equal to the outflow plus evaporation. So it takes 2,700 years to turn it over once. As a result, below 200 meters, 600 feet, it's oxygen free.

Question: I would like to ask Robert Ballard a question. Recently in the Gulf of Mexico, Alvin has been down and poked one of its arms on the floor of the Gulf of Mexico, and they have witnessed oil coming to the surface. My question is—first, a two-part question. Have you actually been down in the Gulf of Mexico in any of your dives, and, secondly, do you believe

that oil does, in fact, flow freely without any kind of a jogging action by something, like Alvin's arm?

Robert Ballard: Well, I'll give that a shot. I've been in the Gulf of Mexico. I haven't dove in areas of organic concentrations. But I have dove in the Sea of Cortez, the Gulf of California. And there you have hydrothermal vents that have been buried by a tremendous amount of organic material coming out of the Colorado River.

You have thousands of feet of very rich organic sediments that have buried these underwater hydrothermal vents. Despite the fact that they've buried them, the hot water still finds it way up through that organic mass. It's coming out at a temperature of about 400 degrees centigrade, so it's hot enough to melt lead.

And on its way up, this geothermal energy has cracked out petroleum. As Mother Nature does it over a much longer period of time. Around the hydrothermal vents in the Sea of Cortez you have natural oil seeps of organics that are just flowing out of the bottom of the ocean without us having to poke our hands into them.

So I know that it occurs there. We all know that natural oil seeps are very common phenomena, having gone to school at U.C.-Santa Barbara and walked the beaches.

Question: I wanted to ask about what happens when the magma comes up. It's being depleted, I would suppose. And is this having any impact on the volume inside and the crust of the earth?

Robert Ballard: Yes. A very good question. You would think that the earth is bleeding out its insides and might become hollow inside. Where the plates come together, one of the plates, and normally the oceanic plate when it hits a continent it goes under the continent. It recycles that ocean floor and puts it back into the earth to make up for the difference.

So it's a beautiful global balance. You have Earth being formed and an equal volume of Earth being destroyed. It's in a beautiful steady-state balance. The earth is neither expanding nor contracting as best we can determine.

Now, creation on the Mid-Ocean Ridge may be compensated by consumption of old ocean floor thousands of miles away.

Bill Moyers: I have the last question. I was thinking as I saw your photographs there on those sunken mountains how ecstatically enraptured the world was when we watched the first man walk on the moon and how woefully unaware we were when you were down there prowling the genesis of our planet. It leads to a practical question. Can you compare the amount

of money being spent right now on basic research of the science into space to the basic research into the ocean?

Robert Ballard: Well, the investment in our oceans is small. In fact, the royalty that oil companies pay to drill oil is not, by our government, reinvested. The government is doing ocean work at the profit. If they just gave us what the oil companies gave them, we would be in great shape.

To me the most important thing to come out of the space program was when the astronauts looked back over their shoulder on their way to the moon and saw Earth. They saw this little green marble in this giant void of nothingness. And all of a sudden the world became very small. I think we've not totally come to grips with how finite our world is, particularly when you realize we only live on 28 percent of that which is called Earth.

We're about to enter a new millennium and I hope in the next couple of years we start thinking about our mission as a species. We're entering a new millennium. What are we going to do in it? And I'd like to see some big thinking start to take place.

William Crook: We're going to break now for lunch. We have a rather light lunch for you, which helps us at a certain age to stay awake in the afternoon.

I want to mention tonight and some of the problems we're going to have with traffic. This is a big day for Corpus Christi with the lighting of the harbor lights tonight, which you'll see. They have parades all day long. So those of you who are going to drive out, please talk to Colleen. She has a map for you. If you can possibly go by the bus, we suggest that you do so. But it's going to require a little detour rather than straight down Ocean Drive.

Please be prompt. You were this morning. We appreciate it. We've deliberately planned a short afternoon. The business meeting today will be brief but very, very important. We're entering that new century Bob was talking about. We've got a lot of decisions as a society to make. Elspeth Rostow was saying yesterday about her committee—we're planning what this society should be in the state of Texas for the next hundred years.

We want you to participate. I especially invite the new members because it will give you a glimpse of the inner workings of the society. Enjoy your lunch.

William Crook: Sorry if I sound a bit pushy, but I'll never have this chance to influence such a crowd again, so I'm going to enjoy it. Come right on in.

I introduced Judith Moyers this morning and said she was the 60 percent asset in their partnership because she has shared in every accomplishment that Bill has made. I want to introduce my 60 percent partner, Eleanor, if she will stand please.

I should have known you wouldn't let me get by with what I told you this morning about Bill Moyers's question on the airplane—on Air Force One when he asked the President, "What are you thinking?" The President replied, "I'm wondering. Are the missiles flying?" Those four words, I think, describe the burdens that our presidents in the past fifty years have had to carry, burdens that we've been very much unaware of. But they also tell us that they aren't flying.

This would be a wonderful time to catch up with the research, move ahead with world hunger, move ahead with the other problems of disease confronting the earth. The money spent and wasted on the *Bismarck* alone would go a long way toward that. If we don't tear this republic to shreds by the shrillness that we're hearing now, by the alienation that seems to be taking place, this country has nothing but a great, great future.

We started with the oceans in the broadest sense. I did not know the interconnectedness of the sky and the sea and the earth. Mary Altalo has put it in terms that even I can understand. We moved on to be more specific as to what's down there. Now, this afternoon we come to study something very special to every Texan's heart—that's the Gulf of Mexico.

Corpus Christi now has the sixth largest port in the United States. We know what the Gulf means to us in terms of commerce and resources, and we need to hear as much about the future of that Gulf, and what we may be doing to her, as we possibly can. I turn the program back to Bill Moyers.

Bill Moyers: Thank you, Bill. Bill and I retreated upstairs during lunch to evaluate the morning's event and to collect our thoughts for the afternoon and the finale tomorrow. And at a moment while he was on the phone, I stood at the window of the room looking at an angle through which I could only see the Gulf. I couldn't see the room to the left or to the right. I couldn't see the beach below me. For a moment the only world that existed for me was the world of the Gulf, which so many of you know so intimately and so fondly on a daily basis.

And I suddenly realized what it was like to be the fish I talked about earlier, to live so uniquely affiliated to this body of water. It was the only view I had of the world at that particular moment.

On any one of the last 2,420 mornings, if you had gone for a walk on the beaches of Port Aransas some twenty miles from here, you would have come upon the solitary figure of Tony Amos. Regardless of the elements, wind, rain, temperature, he walks the shore to collect the telltale evidence

that nature presents to the vigilant eye concerned for even the most microscopic change in the health of our environment.

I should think it boring duty for a man who has cruised all the world's oceans and most of its seas, the veteran of thirty-two expeditions to the Antarctic and five to the Arctic, including several months floating on the polar pack ice. But for eighteen years now, out of love and not duty, he has been making a long-term study of Mustang Island gulf beach. He is widely known in the scientific community for having introduced scientific rigor to the study of beach litter along the Gulf.

He's the only man I know who actually holds a permit to handle sea turtles, dolphins, and migratory birds. And given what we now know about the ecology of our planet, he must sometimes think that when holding one of these creatures, he indeed has the whole world in his hand.

An Englishman by birth, he is now the official United States weather observer for Port Aransas, Texas, and he always gets it right. Tony Amos.

THE GULF OF MEXICO: MARINE POLLUTION

ANTHONY F. AMOS

Thank you very much, everybody. I'd like to start with a little very brief Texas story. As part of my job of traveling the beach many, many days, I often come across a stranded or injured animal. And quite often that is a bird—a sea bird. People know this in Port Aransas and the surrounding community, and so I get calls all the time to come and pick up a bird or come and find a bird that's in distress on the beach.

And one day from Woody's Boat Basin and Bait Stand I got a call about a bird that was on the beach. So I went into Woody's and I went up to the counter there and I said, I have come for my bird. And the man looked at me. And he didn't say anything. And so I said, I've come for my bird. So he looked at me and scratched his head and reached up and picked up a Budweiser can and put it on the counter for me.

I do hope that I can communicate with this wonderful audience a little better than I did there.

I have a quotation here. I won't read it all, but it is interesting and it does say something about the interconnectedness of things. The quotation says, "We found the shore for many miles strewed with fragments of wrecks and boxes and bells of goods which had been thrown into the sea from vessels. We frequently found, as we walked along the edge of the surf, fresh coconuts, brazil nuts, and other fruits and plants of more southern latitudes which, no doubt, had made the voyage from the rivers of the seven continents on the gulf stream flowing from that direction to unite with the other or more northern branch of it. We observed entire sycamores and

other trees from the forests of the north which, coming down the Mississippi and being carried to sea, were also deposited on the shore by the same current." And so on and so forth. It's a longer quote.

The narrator of this quote was one S. Compton Smith, M.D., acting surgeon general with the later President Zachary Taylor's division in Mexico. And he was describing the events following the wreck of the *Rosella* on Padre Island in the spring of 1846.

Well, you could go down Padre Island today, and perhaps you wouldn't see such magnificent trees of mahogany these days, but you would certainly see the wrecks and the bales and the boxes of materials that have been thrown from ships or otherwise found its way to our beaches. The difference, perhaps, being that then, in those days, these were treasures in general. Probably it was a bounty to find a cask of something washed ashore. But today these are far from being treasures.

And although I have come to know and love the Gulf of Mexico, and particularly its margin that is represented by the Barrier Islands, and I would love to show you in my talk today some of the beauty of this place, I am, unfortunately, going to show you some less beautiful objects that wash up these days.

I will start off with some beautiful pictures. The Gulf of Mexico looking from Mustang Island Beach, which is my adopted beach. The Gulf of Mexico is a very dynamic place. And the atmosphere, which Mary was talking about earlier, has such an effect on this that when a storm comes through, it changes the beach face almost immediately and also has an incredible effect on the circulation of these shallow waters of the coastal Gulf of Mexico.

This is one of the few places that has survived since that time—just after that time that the *Rosella* was wrecked. This is the Aransas Pass lighthouse. And this picture illustrates two factors about the Gulf of Mexico. One, it can be a rough place. Now, I have been to the Antarctic as you heard, and I have been in some extraordinarily rough seas. But there is something about a storm in the Gulf of Mexico. It's because the water is shallow, and because the waves have a short period, and because most of the vessels that go out there are a certain length, which is not particularly conducive to that period of the waves, that it can be very rough out there.

The University of Texas has their marvelous research vessel called the *Longhorn*. And one thing that I often feel when we take students out there is that we might be, in fact, discouraging them from ever taking up the pursuit of a career in oceanography.

Oh, the other thing before I get onto that—the other thing, of course, is the presence of commerce and of industry in the Gulf of Mexico, as illustrated here by this rig.

One of the favorite things that I do when I go out on the *Longhorn* is to sit on the bow in perhaps a little more clement weather than we have here and just observe the ocean going by. I've been doing this almost on all of my oceanographic cruises. At one time, I rode the bow of a research vessel coming all the way from the Antarctic to Seattle, Washington, during all daylight hours. And, in doing so, I've got a different feeling for the ocean than I have by sending instruments down and measuring its temperature and salinity and oxygen content.

And one of the things that I've noticed are the things that float to the surface of the sea. And they are in the Gulf of Mexico often wonderful and often less than wonderful.

Another feature of the exploitation of the Gulf of Mexico, other than its industry and commerce in the form of maritime transportation, is the shrimping industry—the primary fishing industry in the Gulf of Mexico.

A feature of our coastal environment is the contrast between the long stretches of almost deserted beaches and the encroaching—ever encroaching development of our resources—our coastal environment.

This is my beach. You are looking at the Aransas Pass, one of the only inlets between the Gulf of Mexico and our extensive bays and lagoonal systems for many miles, both to the north and the south. You are looking south. You can see the wonderful curvature of the beach. And you are looking at part of the town of Port Aransas, Texas. This is the south jetty of the Aransas Pass, and the survey, which I do, starts somewhere around here, and I go seven miles to the south, and I count a lot of things that are countable.

Unfortunately (although it sounded rather poetic that I was like a lone character wandering the beach) I have so much equipment with me now that I have to use a vehicle to do that wandering. And, whereas at one time, I had a clipboard which I was able to rest on the steering wheel, I now have a marvelous little computer which I have had for eleven years or so. I can enter counts of the various things that I find on the beach into that computer. This varies from the birds (I am using the birds themselves as sort of an indicator species to indicate the health of the beach) to cars, dogs, helicopters, people, and a number of things, including the debris and litter on the beach.

I am going to go through very quickly—I violated Bob Ballard's one-minute-per-slide rule here, but I am going to go through rather quickly here to show you some of the horrors of what we find on the beaches and the perimeters of our coastal environment.

This was what I called the day of the milk jugs. You're looking at about 600 one-gallon milk jugs in this one picture. If you look very closely at this material you can see a mixture of the natural and not so natural things. That

is my dime by the way. These are the bleached blades of the sea grass syringodium (manatee grass) which have probably come from somewhere in Central America or Mexico.

These are plastic ferrules or pellets which are the basic raw material for the injection-molded plastics industry. Almost anything that you have in the way of a plastic comb or other plastic object is made by injection molding, and this is the raw material which finds its way onto our beaches.

These are various containers that I've found on the beach—sometimes sealed, sometimes unsealed, mostly empty, sometimes full, sometimes leaking their contents on the beach, sometimes having cryptic seals on them, often having no labels so that you can't blame whoever is responsible. As I say, sometimes leaking their contents—unknown contents—on the beach. This, incidentally, did have a label on it. It came from an Indonesian tanker which was transporting palm kernel oil. I thought this was some evil chemical substance. It turned out to be palm oil. And I learned then by reading the label that some of those tankers that you see are not carrying petroleum products, but are carrying palm oil—gallons and gallons, hundreds of thousands of gallons of it.

Sometimes we find the larger containers, some 55-gallon drums. The national seashore has collected hundreds of 55-gallon drums over the years. Now, because of the unknown contents of some of these, it is estimated that if the Coast Guard is called in to remove them, it costs \$1,000 to remove a single drum off the beach.

This is some familiar caulking material which has interacted with the sea water to form a rather interesting "sculpture." Somebody decided it would be fun to drive over that 5-gallon container once it came on the beach and it spewed its yellow contents onto the beach.

Containers with warning labels. Containers that are leaking. Here is a one-gallon milk jug that has no milk in it, but probably contains used motor oil. You can see that it's leaking a sheen into the precious sea.

Freon—in our throwaway society, there are 50-pound cylinders of freon gas, used extensively in the refrigeration industry. They're non-reuseable. On this particular day, I found fourteen of these on the beach!

Now, I'm going to show you briefly something of the impact on the sea life of this material discarded into the sea. This is a hawksbill sea turtle. This is an onion sack. You might wonder what an onion sack is doing in the Gulf of Mexico. Believe me, there are lots of onion sacks that wash up on the beaches, and they're used, as far as I can determine, primarily by the shrimping industry as a convenient container on the brine boats to contain the shrimp. The animal is alive, although it doesn't look it. In days gone by, this would be made out of maybe some vegetable fiber, but now it's made out of plastic. And although it starts to break apart, it forms a very effective

snare. For some reason, hawksbill turtles have a particular affinity for onion sacks, and I've found nine of them over the years that have been entangled in this fashion in onion sacks. Fortunately, only one has been dead, and we've been able to rehabilitate all of the others.

Here is a loggerhead turtle. Here is another one of the hazards, a fishhook with fishline attached. And, believe me, it is not a very pleasant task to open the jaws of a sea turtle like that and try and extract a fishhook. In fact, in some cases, we cannot do it. We are not veterinarians, and so we have sent off some of these turtles to the Houston zoo, and have them actually operate to remove fishhooks. This one was successful, and we sent it back to sea.

Here is a much smaller loggerhead turtle with some fishing line around its neck that it has worn for so long that it has actually begun to grow around it. And you can see the edema, the swelling of the neck there. Again, once we found this animal, we were able to remove the fishing line and rehabilitate it and send it out to sea.

One of the most absurd things about pollution of this sort is what you find in the stomachs of dead turtles that wash up on the beach. I have, in fact, if anybody is interested, some "show and tell." Pam Plotkin, a student, opened up 110 loggerhead turtles that washed up dead on the beach over a year-and-a-half period. She looked at their stomach contents, primarily because her thesis was to find out what loggerhead turtles were eating. What she found out was they were eating plastics. Over 50 percent of all those sea turtles had plastic in their stomachs. I actually have behind there a box of all those plastic pieces that came out of the stomachs and guts, which anybody's welcome to come and look at afterwards.

But this was one of the most absurd items found. It is one of those tags on a pillow that you're not supposed to remove. Otherwise, you go to jail. And somehow this turtle ingested it, along with its other food material here. But you also see other bits of plastic along with it.

Here is a Morton Ship-N-Shore salt bag. This also is used by the shrimping industry. I show this for two reasons. One is that the shrimping industry has been blamed, although they vehemently deny it, as being one of the major polluters of our beaches on the Gulf of Mexico. But I show it for that and also because if you turn that over you would see what that salt was used for. It's used for separating trash fish from your catch. It's written right on the back of the salt sack. But I also want you to note these diamond-shaped holes in it. These are turtle bites. We don't quite know why turtles bite these plastics, but we believe that for millennia, hundreds of millennia, turtles have been able to bite anything that floats to the surface, and it was probably food. Well, now, it's certainly not guaranteed to be food.

And the birds get entangled, of course. Here is an immature herring gull—second or third year herring gull, trailing a length of monofilament line attached to its leg.

This is a bird which I followed for a long time. It's a ring-billed gull with a piece of plastic that restricted its leg until the leg went gangrenous, atrophied, and actually fell off. And it survived for a year after that and then disappeared.

Here is a redfish. This is the joy of the Texas coastal fisherman. But this one has a gasket from a big oil filter around its gills. It must have lived with this for months and months because it eventually eroded the gills away so that the animal could no longer respire. And big redfish, by the way, live for fifty or even sixty years.

Here is an even smaller fish that is entangled in the funny little diamond-shape holes in the six-pack rings. You've heard, I'm sure, of birds getting their necks in six-pack rings. But here is a halfbeak gilled by a six-pack ring!

Perhaps the saddest incident of all that I've been involved with concerning plastics is this 18-foot Minke whale, a baby Minke whale, which washed up on Matagorda Peninsula a few years ago during a norther—and really cold Texas norther weather. It was alive. It weighed about four tons. It died on the beach. And when it's stomach was examined, it had one single piece of plastic and nothing else in its stomach. And we believe that was probably what caused the death of this baby animal.

Well, the other thing that we have to deal with here is the industry that involves the extraction of oil and gas from the Gulf of Mexico. And one of the features of our beaches is the quantity of tar that you often find there. Several years ago, the IXTOC I well blew in the Gulf of Campeche, to our south in Mexican waters. For 295 days, or thereabouts, it spilled oil into the Gulf. The University of Texas Marine Science Institute did quite a bit of research on how that oil would flow with the currents, and eventually when it would come ashore on the beach. Then, ironically, a little bit later, the oil tanker *Burmah Agate* exploded and caught fire to our north. Currents were coming down from the north, and currents were coming up from the south, and we were right in the middle. And this was the result on our beaches. I followed the reefs of oil that persisted off Mustang Island for a period of eight years. I believe they are still there now, but I think they're buried in sand.

The removal of tar from a beach like this is a terrible process—it's a nightmare process. I will say, however, that we have seen far less in the way of tar balls washing up on our beaches in recent years. Maybe it's because I've removed so many with my sneakers. I don't know. But it's one of the hazards—in fact, all the condos in Port Aransas and elsewhere have little cardboard boxes in front of their doors with cleaning fluid, and they ask you to remove the tar from your feet.

You're looking at what resemble miniature volcanos here at the edge of the surf. These are the burrows of the ghost shrimp, a very common invertebrate locally. What happened with oil from the IXTOC spill—when it became mixed with sand, it flowed down the burrows. When I excavated them, I found perfect casts made out of tar. One method of studying animal burrows is to pour epoxy resin down the burrow and then excavate the sand when the epoxy was hardened. In this case, the "resin" was tar. Taking a cross-section, you can see where the animal cemented the sand together. Now, the burrow is permeated with oil, with liquid oil in the middle.

And, of course, it has an effect on the birds. Hundreds of shore birds were oiled following that and several other spills that we had later. This was interesting—somebody who'd just got interested in birds came to me in great excitement saying they'd discovered a new species of seagull. It was, in fact, not a new species. It was a laughing gull that had fallen into something. I never found out what. It could fly, and I wasn't able to catch it.

Well, I'll leave you with a few thoughts on the beauty of the beach, rather than "the beauty and beast," and how I do still see the Gulf of Mexico and its borders as beautiful. But I do believe that we must be vigilant in the way that we treat our waste products. I think there are lots of forward-going projects now to prevent us from dumping so much in the sea. We must educate, and we must really do something about this problem so that we can keep the Gulf looking like this.

One of the most marvelous sights that I see in the early mornings, both in spring and fall, are the mass migrations of herons and egrets. In this scene there are snowy egrets, cattle egrets, little blue herons, tri-colored herons, and great egrets all flying by at the same time in the early-morning sun. It's a wonderful sight. But I just briefly want to show you how it's not only the Gulf of Mexico that this problem affects. Here is one of my favorite places in all of the world, the beautiful Antarctic Ocean. And this is what we have done to some of those remote islands by leaving our junk there. These are elephant seals which have sought refuge in some discarded hose material. I don't know whether they thought they were kin or what, but they couldn't be moved. You don't try and move a one-ton elephant seal, even though they are rather lethargic.

And I'm just going to leave you with two more slides with a thought about the interconnectedness, if you like, of the sea. What you're looking at here—and this is exactly as I found it on the beach—is a black drum which was caught somehow swallowing a hard-head catfish, and the reason why it was caught in that position was that at the very instant that it was swallowing that fish, a much larger fish came and bit a chunk out of its tail and finished its existence. So big fish eat little fish, and so on, ad infinitum.

So I'll leave you with that and be happy to answer any questions.

Bill Moyers: That's an optimistic way to begin the afternoon. But I do appreciate the confrontation you present with reality, Tony. I want to ask the first question. On a scale of one to ten—in terms of saving the oceans—where are we?

Tony Amos: I think we're probably about halfway there. I think, as I said, a lot of progress has been made. I've recently sat on a committee to investigate the problem of shipborne litter. Industry has become very aware of this problem because it's not very good for their image. And so many of the industrial firms have educational programs for their workers, and they've had to, of course, because we have an international agreement now called MARPOL Annex V. It's been in effect for over five years now.

And our Coast Guard does inspect vessels that come into our ports, and they inspect them to see how many people are on board and whether the amount of garbage that they have still on board is commensurate with the number of people. And if it's not, they can get them even if they don't find the garbage, because they know they've had to throw it over the side.

I think we're making progress. And I have seen—maybe a six out of ten—I have seen an improvement in my beach survey in the last four or five years.

Bill Moyers: Do you think that's true elsewhere in the world?

Tony Amos: The other world is following. The U.S. was perhaps the first country to become really aware of this program and do something. There is a vast volunteer effort, as many of you probably know, that is done every year. It was started here in Texas, by the way. It's called the Great Texas Trash-Off here. But every September, and here in Texas every April as well, thousands of volunteers come to clean our beaches. And although it may be disheartening for them to clean the beaches, if they were to come back the next day and see it just as bad as they saw it before they cleaned it, that might be disheartening. But what is really good is the people get to look at that. It should be required viewing for people to go and see how much plastic has permeated our environment and how much waste material there is.

So the educational project has been—progress has been great. And now that's worldwide. There is even a cleanup going on in Antarctica this year—and about time, too.

Bill Moyers: If you could make one change that would eliminate maritime waste at its origin, what would it be?

Tony Amos: Well, it would be less packaging material. Now, of course, packaging and plastics have been our salvation for many things—prevention of disease, preservation of food, and so on. But I think that we've gone too far, in our packaging materials, to make them attractive so that people will buy them. And that we need—I think we're trending towards that now in fact, to go back a little bit and use things more perhaps in bulk, especially on ships.

I've recently been on a Russian ship where they put very little garbage into the sea, primarily because—not because they're any different human beings in their nature than we are, but because they don't have so much packaging materials. Their materials come in sacks, if they come in anything, or cardboard boxes, but not in all that plastic.

Bill Moyers: Have you noticed any significant change in public attitudes in these years that you've been here?

Tony Amos: Yes. And I think the media is, in fact, responsible for some of that, too. We often knock the media, but there is no doubt that the media does make available to the public certain indelible images. There's nothing like an indelible image like some of those trashed-out beaches. I think that has probably changed public opinion, or helped to change public opinion, as well as education—education of the very young. I'm sure many of your children or grandchildren know now that you don't just chuck your candy wrapper on the floor, that it might, in fact, affect some distant organism.

Question: Now, garbage is something that's close to an archaeologist's heart, something I can relate to. One of the most common things that you find out about shipwrecks, particularly the Spanish treasure ships, is that the beaches are full of the coins that were on those vessels. That is true in Florida, and it was also true in the case of the 1554 Spanish treasure ships here in Texas. And, in fact, those same Zachary Taylor soldiers—a group of them went down Padre Island on the way to the war—found some of the coins on the beach from the Padre Island treasure ships.

So in a way it's also interesting because sometimes these sites aren't really lost. I mean, everybody knew those coin beaches were there, and there's only one reason the coin beaches are there. It's because there's a wreck offshore. And that leads to another thought—that the watermen often know where all the wrecks are also. They don't necessarily know which wreck's which, but they snag their nets on the wrecks.

Tony Amos: Can I relate a modern anecdote about that? We have some people on Mustang Island who go out looking for money right now. It's a

different kind of money. It's drug money that is dumped into the Gulf of Mexico and often washes up on the beach in large quantities. I think the only thing I ever found was a dollar bill.

Question: I have a question. One of the things that—I don't know if it's pervasive through the United States, but certainly in the community where I live, is this Adopt-a-Highway where different organizations, different people take on one mile of freeway and see to it that it's clean. Either they pay to have it cleaned, or their people go out, if it's a local McDonald's, and they—or you see them going up and down the highway constantly keeping it clean. And it does a lot of things to you. It makes you feel good about people that care, but it also makes you conscious in some ways of the price that's involved.

Have you ever seen any sort of thing like that where a community or someone might adopt a section of the beach and make it their responsibility to keep it clean, which also just instills in young people the realization it can get dirty in the first place.

Tony Amos: Yes, indeed. There is a Texas Adopt-a-Beach program that's been in place for several years. It was originated by the Texas General Land Office Commissioner, Gary Mauro. And that is a very viable program. The other thing, which I didn't mention, is that the volunteers for all of these cleanups are asked to fill out data cards, and so, not only do they know what they've picked up, but then we, as scientists, know what they pick up. Now, there have been some criticisms about whether that data base is going to be statistically viable. There is a big national program just starting, or will start next year, where volunteers will clean up beaches at monthly intervals, using identical methods (recommended by the scientific community) so that we will be able to ask that question which I spoke about earlier. "Is it getting better or is it getting worse?" My own measurements say it's getting better locally. Other people say it's not, but I think nationwide we might be able to answer that soon.

I don't remember the length of all Texas Gulf beaches. A very small proportion is adopted, but I would say every year, about 180 miles of our beach actually gets cleaned. It's somewhere in that area. It's two-mile sections they adopt.

Bill Moyers: I asked a friend of mine on Wall Street if he was optimistic about the market. And he said, Yes, I'm optimistic. And I said, Then why do you look so worried? And he said, Because I'm afraid my optimism's not justified. I have that fear, Tony, that your optimism may not be as justified as I want to believe it is.

Tony Amos: Well, I will admit I'm an optimist. I have a certain faith in humankind. If you show them what's going on, and you see the interest that people take in some of these animals that wash up on the beach, you realize that people do have concern. They're just bloody careless at times. That's all.

Bill Moyers: If there is a cause for optimism, it's in no small part because there are people inspired to imagine a future that is more hospitable and more compatible to what we're talking about, and to work toward it. And one of them grew up right here across the bay.

Tony came to us from England via Bermuda, but John Wesley Tunnell actually grew up on the other side of the bay and has stayed at home to work in this field. It was his concept that has led to what will soon be a new \$10-million center for environmental studies and services building which will soon be completed at Texas A&M University-Corpus Christi. And from there will certainly come a whole new crop of young men and women devoted to continuing the turnabout that many people think we have made in our understanding of environmental sciences and marine exploration.

Wes Tunnell is one of the pioneers in Texas's own revisioning its future. He is director of the Center for Coastal Studies and professor of biology here at Texas A&M University-Corpus Christi. He has been a Fulbright scholar. I asked him how he got started in this work, and he said, "Well, it was natural. I began as a dentist." And his journey from there to here is an interesting story. He says, I do what I do because I'm in love with the sea. Wes Tunnell.

THE GULF OF MEXICO: GULF RESOURCES

JOHN W. TUNNELL JR.

Thank you, Bill. It's really a pleasure to be here. I'm going to use the remote since these things are usually too short. I'd like to welcome you to Corpus Christi and to the Coastal Bend as a third-generation Texan. I feel like I can welcome you to this area. I know some of you are from here.

I know as a professor this is a bad time to be lecturing—also after dinner, and especially when I turn out the lights. It's more like siesta time than listening time. But I feel like this audience is like some of the organisms that I study—mostly the invertebrates. And I feel like you're a bunch of sponges. You're soaking up everything that's going on here. Everybody's asking these intriguing questions.

My wife asked me, What time is your talk this afternoon, looking at the paper and the 2:30 game time. And I said, It's at 2:00. Poor Barto. I don't know how many people are going to be around when it comes to his time.

I would like to take the opportunity to show you kind of photographically

the resources of the Gulf of Mexico, some of the impacts and problems that we're having, and then maybe talk about a few solutions at the end. It will be kind of a photographic coverage or essay of this area, and I'd like to have the lights all the way off also.

My colleague and associate director of the Center for Coastal Studies, Dr. Quenton Dalen, helped me with the preparation of this material and may field some questions from you later on today or tonight.

Our Gulf of Mexico, America's Sea, as it's sometimes referred to, is an enclosed area, making it somewhat unique. Only two deep-water openings between the Yucatán and Cuba and Cuba and Florida get into this area. About 1,600 miles of the Gulf are along the U.S. shoreline, and another 1,000 miles along that of Mexico.

The resources are wonderful, and we could talk about them for a long time. I'll just give you a sketch of this. The northern area is primarily temperate shorelines with estuaries and marshes and beaches. The southern area is more tropical, like if you were in the Caribbean. Many people don't realize, especially those who've only ventured to the northern Gulf of Mexico, that the southern part has tropical lagoons and mangroves and corals reefs. There are a high productivity and value of shellfish and finfish, as well as vast oil and gas reserves in the Gulf of Mexico.

To show you a few of these, and many of you have seen some of the beautiful beaches from the northern Gulf of Mexico, the salt marshes that are so important as nursery areas and protectors of our shoreline and filters, the vast seagrass beds that are nursery areas also and with a high diversity of organisms. Oyster reefs that are more common on the upper Texas coast than the lower Texas coast, but also very abundant over in Louisiana.

An area that many people aren't aware of. In the Laguna Madre of Texas there are over 350 square miles of wind tidal flats; these vast areas that seem almost completely flat—very, very gentle slope to them, as you can see in this picture. Vast nesting areas or rookeries for sea birds along the Texas coast within the bays and estuaries.

To the south of us, a great contrast along the shores of Mexico. If you've been to Hawaii, you might first think that I stole this picture from there. It's not. It's down around the area of Vera Cruz, Mexico, where volcanic mountains reach the shoreline of the Gulf of Mexico. Many of the beaches in the southern Gulf of Mexico are black in color, not from oil, but from the volcanic sands that come down the rivers from the Sierra Madres and the mountains that are inland from there.

Instead of having estuaries with grasses along the shoreline, we have mangroves, these trees that literally can grow in the salt water.

Coral reefs are abundant in the southern Gulf of Mexico. In the southwest and in the southeastern portions, over thirty-eight coral reefs reach up to the surface of the sea.

Again, most people who have not ventured to that area would expect this photograph from Alacran Reef off the northern Yucatán to be from the Caribbean. It's not. It's from the southern Gulf of Mexico. A great diversity and variety of marine life is associated with these beautiful reef systems.

Sea turtles. The Gulf of Mexico has five species of sea turtles, as many as any other sea or ocean in the world. All of those are endangered or threatened because of various aspects of their livelihood. And they nest on these coral reef islands.

Sea birds on these islands are tremendous also. I had the opportunity to live in Mérida in the Yucatán for a year to study the coral reefs there. And some of the birding activity and birds that I studied as a sideline were one of the greatest highlights there. I actually got—these are Masked Boobies, the name of this particular bird, and there were about five or six species and thousands of these on these islands. I got in quite a bit of trouble when I got back from this research trip and my wife found out I had been on a tropical island studying boobies.

If I could give you a few statistics that we can see here about the Gulf of Mexico. Here you see more finfish and shrimp, shellfish, annually from the Gulf of Mexico than any of these other areas along the Atlantic coast, to give you a comparative view. A familiar sight to any of you who travel along the northern Gulf Coast and the ports of the fishermen who live there.

Tourism. Twenty billion dollars annually generated by our Gulf shores. Another familiar sight, especially on holidays and weekends, on the beautiful beaches of the northern Gulf of Mexico. More than 76 billion in federal dollars, into the federal revenue, because of the oil and gas industry between this period of '56 and '84. Just to give you an idea, that's a second only to income tax. That's what's been generated from there.

Ninety percent of the offshore oil and gas industry—its production comes from the Gulf of Mexico. Familiar views like this, primarily off the Texas and Louisiana coast. There are over 3,500 of these platforms now in the northern Gulf of Mexico.

Down below an unbelievably beautiful world of an artificial reef. Vast array of invertebrates that attach to the legs of these platforms, which generates lots of productivity in fish that come around. You can see divers here studying these from our Institute. Amazing schools of fish that are found around these offshore platforms.

Our Gulf ports, 45 percent of U.S. from Gulf of Mexico ports. The larger ones are Tampa, New Orleans, Houston, and Corpus Christi. Four of the top ten in the United States are here in the Gulf. A familiar view of the Houston ship channel, Houston in the background.

One-sixth of the U.S. population now lives along the Gulf Coast, and it's increasing. If you look at some of the numbers and don't try to—and you

can't even focus on those smaller numbers, but just look at the trend from the bottom to the top of that last one—the Gulf-wide idea that you see there is the increase that is taking place along the Gulf shores. We're told that as much as 80 percent of the population of the United States now lives within a hundred miles of the shoreline.

Gulf coastal wetlands—very vast in the southern part of the United States. Over half of the wetlands are found in our area of the Gulf. Very important as nursery grounds and erosion control areas and filters for water that runs into the Gulf. Critical habitat for waterfowl. Seventy-five percent of the United States ducks and geese move through this area. Those of you from the upper Texas coast may see this as a familiar sight.

Why should we be concerned? Those of you who are lovers of the outdoor or hunters or fishermen could come up with a long list, and these are just a few. But some of our scientific concerns are low oxygen levels that have been found. To the west of the Mississippi River, there's a bottom area known as the dead zone, between 3,000 and 5,000 square miles in size now. Toxic substances that are in our bays and estuaries. Lavaca Bay is the most polluted bay in the United States with mercury contamination. Two-thirds of the United States drains into the Gulf of Mexico. Anywhere between the Appalachians and the Rocky Mountains you put something into a stream or river, it's going to wind up in the Gulf eventually.

Over 90 percent of the Gulf fisheries rely on our estuaries. Part of their life cycle ties into the estuaries.

Human health concerns. Over 34 million acres—that's about 57 percent of the shellfishing area in the northern Gulf of Mexico is closed to harvesting because of contamination. Why? What's the problem? You saw some earlier slides. Too many people. Too much pressure of various kinds. One hundred, two hundred years ago, the people along the coast were small in number, and their impacts were small. But as the numbers continue to increase, we have to learn how to better manage that and take care of it. That population trend that you saw, Florida leading the pack in increase from the '60s to 2010, a fifty-year span—you see Texas is second in line there as far as increase is going. Almost 150 percent growth.

We'd like to break these impacts down, the problems that we see, into two areas—natural and anthropogenic. The natural ones, such things as hurricanes, cold fronts, and fresh-water inflow, whether it be too much or too little. Hurricanes are familiar to us on the Texas coast. Here Hurricane Allen in 1980 cut 36 passes through a 24-mile section of South Padre Island.

On northern Padre Island 120 feet of dunes were cut back, but they stood because of the vegetation there. The low dunes on Padre and Mustang

Island were leveled and water was one foot below the sea wall right out here in front of the Marriott Hotel during that time.

The 1989 freeze in December of that year. This is a familiar sight probably to Dr. Ballard and those of the east coast, but a very unfamiliar sight to those of us along the Texas coast. First time I'd ever been able to walk on Corpus Christi Bay, ice extending 150 yards out. Laguna Madre had a sheet of ice all the way across.

This is what we often see from these severe freezes in our area where fish aren't accustomed to that. We also might see a sight like this with the red tide that occurs occasionally in our area.

The fresh-water inflow in Mexico, around the coral reefs, there has occurred for millennia, but, yet, the deforestation up in the mountains, the agricultural runoff, and the cutting of the mangroves—we see kind of a coupling of manmade activities with natural activities—is now killing the reefs in the Vera Cruz area.

The anthropogenic impacts are human ones. First, in the Gulf of Mexico, offshore, oil and gas, different kinds of pollutants or exploitation of our fisheries. The IXTOC I oil spill in 1979 that Tony mentioned to you a while ago blew for almost nine months—134 million gallons of oil into the Gulf of Mexico that reached all the way to the Texas coast.

The Kemp's Ridley sea turtle had a population of 40,000 back in the 1940s. In the 1960s it had 400 left. Drastic reductions in the populations there.

In our bays and estuaries, the list is longer of the impacts or problems we see there, from dredging, fisheries declines, habitat loss and erosions, others. Let me show you a few visual aspects there. From 60,000 feet up, if we look down, we can see the impact of dredging along our coastline. The dredging is necessary for the passageways for shipping, but it has had an impact in our coastal areas.

Even in the more remote areas of the Laguna Madre, with Padre Island on your right and the King Ranch on your left, you see this long chain of dredge material islands that separates the lagoon. On the ground or in the water, the Laguna Madre open-water dredging should have been stopped long ago. But it still occurs and impacts the habitats that are there.

Dredging in this case, creating finger canals for northern Padre Island and all the islands that you see in this area. Although they have a negative impact, they also have a positive impact with the nesting sea birds that we saw a while ago that utilize those.

And the Florida coast—this is a familiar sight to see barrier islands almost loaded to the hilt. What would happen if a storm came through that area?

The IXTOP oil spill again—a band of oil 30 feet in width from the Rio Grande to Port Aransas during August of 1979.

Beach erosion at Sergeant Beach on the Texas coast. This house was built behind the dunes twenty years ago. In a few more years, it'll be out in the water. There are other houses to the right of this picture that were out in the water, only the stubble of the pilings left.

This is a marsh area in Galveston Bay that used to be solid. Now, with subsidence because of the removal of oil and gas from below that, and maybe sea-level rise combined with it, we see the marsh deteriorating.

The invasion of the brown mussel to our Texas coast now covers the jetties along the south Texas coast completely, as you can see in this photograph. There are diseases that are starting to infect some of the corals of the southern Gulf of Mexico—this black band disease killing this particular coral. An unknowing bather walked through this pile of oil that had drifted in from the IXTOP spill and ringed the islands in the southern Gulf around the reefs like a donut.

This coral reef in the 1970s, today looks like this. No more coral, just algae. That was in the shallow water. In the deep water, where we now see the impact taking place, if you can focus right below this diver on this coral head, now you see algae attached all around that coral head. We now have algae reefs instead of coral reefs because the ecosystem has become totally out of balance, because of our inputs into the Gulf waters and our effects due to overexploitation of resources there.

Why should we protect the Gulf? Again, you could come up with your list, but we'd like to have it healthy for the ecosystem and ourselves, tourism, recreation, simply quality of life. What's being done? Lots of things are being done.

The Gulf of Mexico program was created a number of years ago. In its first year, a good comparison to show you is that the Chesapeake Bay received \$17 million in funding a number of years ago, and the Gulf of Mexico received \$1 million. Think of the size difference in the two. So we've tried to make a focus on the Gulf to start doing these things to help restore and enhance it, as you see here, and manage it in a better way.

Here you see agencies, U.S. Fish and Wildlife, joining with private industry, Conoco, and private individuals, to stop shoreline erosion in whooping crane habitat in Aransas National Wildlife Refuge.

We see special kinds of technology coming along now to stabilize the shoreline and then plant natural habitat back behind that to try to gain some of the ground we've lost. Another area that was upland is now bay bottom and marsh area.

The sea turtles I mentioned earlier that were down to 400 in the 1960s—this last June, they'd had as many as 1600 come in. And each of these that

you see in this compound to protect the turtle eggs, is a nesting site that's been transplanted here to protect them. 1600 were laid this last time, the largest since the program started in 1968.

Tony already talked much about this, our cleanup efforts that are going on.

I close with what are we doing or what are we going to do? As a research scientist, I'd say research. We need more research and jump up and down on the podium and say, Send more money. But we know that that's not the only way. We have to have management. And kind of what Bob Ballard was saying earlier, we need to be visionary as to what we're going to do, not crisis management when it happens, but to take care of it ahead of time. We need to sustain the harvest of what we're going to do, rather than exploit.

How can we fund this? And Bill Crook asked me to be a little provocative. And this will be my provocative aspect for you to talk about. And Bob actually alluded to it a little earlier—space, i.e. challenge means. Let's get more of a balance of money going into the ocean, the study of sea technology, and research for the ocean, as we do into space. Dr. Dalken pointed out to me a year or so ago, and I've taken up the banner, that what have we brought back from space? We saw some good photographs earlier, and that's helped us in oceanography. Have we brought back any resources like we've seen from the Gulf of Mexico and from the other oceans of the world?

Let's look for and try to get a balance more in funding where we can put more to study and work within there. We need this development triangle, as I call it, not only economic development, but we must consider social health and environmental quality as we move along.

So the challenge for 2000 and on in the next millennium—three C's, collaborate, cooperate, and communicate. We need to form partnerships, whether it's with private industry, foundations, or agencies and academia. We need to all get together to work for that.

And I'll close with an example of our university and the game that's almost about to begin. We're only a little satellite of the mother ship as we understand from the main campus. But, for example, we have cooperative agreements with state and federal agencies on our campus. This new building that Bill mentioned a while ago to put together state and federal agencies in academia and research. The Flower Garden's Ocean Research Program that Dr. Dalken heads, brings together industry and academia for doing those kinds of things. We take our students in the field with the agencies so that they can hands-on learn these kinds of things.

This is the example of our new facility—a 100,000 square foot, \$10-million facility—to bring together state and environmental management agencies working with research agencies on the university campus. Just

down the hall, local builders and developers call it one-stop shopping. When they have to go for their permitting activities, it's all in one place, so we like the idea also.

The Flower Garden's program is working primarily with Mobil and British Petroleum, where Dr. Dalke has arranged this program whereby industry puts in the money for supporting the research activities.

And I'll close with noting the Gulf of Mexico Foundation, an organization that Dr. Dalke also works with, which is set up for education and promoting education about the Gulf of Mexico and enhancing and preserving it. And as we all work together in that with industry, agencies, academia, and citizens, we'll see that we can achieve. Thank you.

Bill Moyers: You were talking about the financial situation and I remembered that when our oldest son turned sixteen, he asked for an increase in his allowance. And I said to him, Well, you know, son, there are some things more important than money. And he said, Yes, Dad, but it takes money to date them.

The fact of the matter is, it takes money to do this work. And it doesn't have the priority that some more immediate things do. Do any of you have a response to what Wes said—or questions? Yes, Mary.

Mary Altalo: I just have a comment and what's spurred a lot of interest. First of all, because of the coastal region—you are showing very nicely in your set of slides the diversity and the number of parameters that you have to measure, which is, again, much of a challenge.

The second thing is that the time frames that you have to measure these parameters in is very, very rapid, simply because of the rapid changes. That takes very detailed observation systems. And while NASA has established and has sort of turned around and put together plans for Planet Earth, for Mission to Planet Earth, a lot of times the instrumentation that's up there, the satellites, which are actually observing Earth, are looking at a very large footprint. Very nice for looking at the open ocean, but when you get into the coastal region, you cannot observe on the time and space scales that are necessary for the kinds of preservation that you need in the coastal region.

So I urge that not only do we have to educate them to look towards Earth, but also to provide things on the appropriate spatial scale for looking and preserving the coastal region.

Barto Arnold: This fall saw the completion of a landmark in the historical study of the Gulf of Mexico, the publication of the third of Robert Weddle's books on the exploration of the Gulf of Mexico, the first being *The Spanish Sea*, and then *The French Thorn*, and now the third one, *Changing Ideas*.

He takes a broad regional, synthetic look. So often when we hear about the explorers of the Gulf, it's from a state by state perspective. Weddle's books are unique and interesting in that he looks at what's going on in the whole region of the Gulf shore at one time. I highly recommend those books. Bill Moyers: I don't understand how this projection of population growth and accumulating pressure can be offset by the relatively modest efforts of regulation and conservation. I just don't. I have to be honest and say that. It seems to me that the cheerful, ruthless dynamism of human activity is going to overwhelm us.

Robert Ballard: As you said from the man on Wall Street that the reason he was gloomy was that he wasn't sure his optimism was justified. And I must say, I'm in the same boat. I'm an optimist, and it's hard to tell the horrible, horrible news.

But, clearly, when you bring any group of scientists together, almost regardless of discipline, and you ask them the single most important challenge to the human race, it's global population. And I think all of us see that that's the enemy.

Bill Moyers: Bill Crook and I decided arbitrarily, as these totalitarian societies are wont to do here in Texas, that we were going to change our agenda tomorrow morning. We are going to open the questioning to the microphone—anyone can ask a question from the floor.

I hope some of you will think overnight about this philosophical question which has been raised by our scientific guests: What makes us think that the human race is the end of this whole process which may have begun on the ocean floor? Why do we want to assume that the human race is the purpose of nature?

There's no one in this room I admire more than I do Barto Arnold. He went to Austin to attend the University of Texas and never left. Despite having bitten deeply into the fruit of the tree of knowledge, he just simply couldn't part from Scholz's Garten.

He earned two degrees at UT in preparation for a career in land archaeology, which is why he spent the last twenty years in marine archaeology. And how did that happen? Well, his adviser assigned him to clean artifacts from two Spanish vessels that were sunk in the Gulf in 1554, about the time Cactus Pryor arrived in Texas. And Barto's imagination leapt from shore to sea, and his life's destiny followed.

Since 1975 he has been State Marine Archaeologist. The story of his discovery of La Salle's ship *Belle* is a fascinating account of marine detective work, and a reminder of a fantastic discovery made on a very modest budget.

The president of the Society for Historical Archaeology, Barto Arnold.

THE MYSTERY OF MATAGORDA BAY:
AN ARCHAEOLOGICAL DISCOVERY

J. BARTO ARNOLD III

Thank you very much, Bill. You remember that La Salle was the French explorer who had a prominent career in Canada, or New France, and the upper midwest and the Great Lakes area before he went down the Mississippi River in 1682 to discover its mouth. By reaching the mouth of the Mississippi first, he had the right to claim the whole drainage of the Mississippi River for France—half the continent. So he was already a big deal by the time he came to Texas. He went back from the mouth of the Mississippi to Canada, and then to France, and convinced the king to send him to the mouth of the river via the Gulf of Mexico to plant a colony. Unfortunately, he missed. They could do okay determining latitude, but, at that time, they couldn't determine longitude, and the Gulf has a featureless shore, and he ended up in Texas.

About 300 people left France in four ships. They lost one ship on the way over before they even got here—captured by the Spanish. They stopped briefly in the Caribbean and then came on to North America, hoping for the Mississippi, landing in Texas on the 1st of January in 1685.

As they were trying to enter the bay, the main supply ship of the expedition was lost. The *Aimable* was lost in the mouth of Matagorda Bay. So they were really behind the eight ball before they got started.

The last big ship of the expedition had intended, and indeed did, return to France, the *Joly*, and a lot of the people who were going to be part of La Salle's colony decided that things weren't going well and they went back home. He ended up with 180 people in Texas, established his fort and his colony, and set out to explore the area to find the Mississippi River.

One of the key factors in that exploration was the *Belle*, a small six-gun ship, 65 tons, intended for exploration and communication with the outside world, should this French colony get in trouble. La Salle was exploring by land and going to the eastern regions of Matagorda Bay to meet the ship. The *Belle* had gone in advance and anchored there. The crew ran out of water, the captain and a large part of the crew went ashore and spent the night. Bad decision. The Indians killed them as they were camping there. And naturally the rest of the people didn't want to go look for water any more after that. So they were suffering from lack of water and had to drink wine instead.

The crew was depleted in strength and in numbers, and a norther hit in January of '86 and blew the *Belle* across Matagorda Bay to wreck behind Matagorda Peninsula.

La Salle's party went back to Fort St. Louis after finding the *Belle* missing. And some months later, after being stranded on Matagorda Peninsula, six survivors of the *Belle* made it back to Fort St. Louis. They found a canoe and were able to get back. The captain stayed drunk for three days after the ship wrecked.

In 1687, La Salle decided he would have to go back to Canada to bring help, and set off with seventeen men, leaving only twenty survivors in the Fort. These people suffered from smallpox and an Indian attack, and, finally, were wiped out. La Salle himself was assassinated by his own men.

Later in that year, the Spanish, who had been sending expeditions to search for La Salle, found the wreck of the *Belle* and decided that the French had failed when they found this ship heeled over on her starboard side. The Spanish salvaged what rigging was still good and reported that the ship looked almost new. They took rigging and cannon and went on their way.

When the Indians attacked the fort everybody was massacred except for a few children, who, as often was the case, were taken to join the tribe. Later those children were rescued by the Spanish, as were some of the French deserters. Through the period of this couple of years, some of the French deserted to the Indians to live in the wild, got tired of that, and sent word to the Spanish to come save them. And that's how the Spanish finally found Fort St. Louis.

They reoccupied the fort, established a presidio and a mission, which stayed there for a couple of decades, and then were moved inland.

One of the problems that not being able to know your longitude caused was that some of the maps of the period showed the Mississippi River coming out in the middle of the Texas coast instead of where it really is. It was another 100 years before they really got down the determination of longitude so as to be able to find the Mississippi very well.

Both the Spanish and the French records gave us the general area to search, within a few square miles, and we did our survey and found the wreck.

The main remote sensing tool we were using for our work was a magnetometer. We were searching not just for the French wrecks. This was an important historic area. There are a lot of interesting shipwrecks in the area. Indianola was a major port in the 1860s and '70s, and was a rival of Galveston, in fact, until it met its fate. A couple of hurricanes wiped out Indianola with large loss of life.

The pass has always been very treacherous, and, in fact, in modern times, there's a dredged and jettied entrance through Matagorda Peninsula that's used instead for shipping. There was a lot of activity here in the Civil War as well, and a lot of shipwrecks.

We did our first major survey in this area in 1978 and found several of

the mid-1800s steamships that related to the Indianola period, but did not find La Salle's ships. Through several shorter term projects that went on in the interim, we continued on looking in the area—the Pass Cavallo area changes a lot. The deep-water channel runs right along the shoreline, and there's a very shallow-water area of islands and sandbars that comes and goes in the area.

And, in fact, the pass has changed entirely with a spit of land emerging. Since 1978, the bay entrance has closed in a lot. There have been big changes in the coastline.

One of the things that we were interested in aside from the shipwrecks were lighthouses that were built out in the bay on pilings. They were occupied for just a few years in the 1870s when Indianola was a port. The lighthouses are a very interesting kind of archaeological site because, in most sites, you are dealing with decades or hundreds of years of refuse that builds up in one spot, and it's hard to determine what any artifact relates to except in a general period.

In the case of the artifacts that we find around these screwpile lighthouses, you can put one or two guys' names on every bottle and plate and bone and piece of trash around these sites, and you can assign a three-year period. Those are a really exciting kind of site for archaeologists because you can zero in on the dating, and you can make a connection with individual people.

We found in our magnetometer survey four or five years ago a really huge magnetic anomaly with one of the lighthouse sites. And then we surveyed for the other one this summer.

In 1860, a view of the town of Matagorda was engraved. It's an engraving done by a German. And in addition to seeing the little town one sees several kinds of vessels and the pier. The piers are really interesting for archaeology because a lot of objects would have been lost over the edge of a pier.

In Caney Creek, that leads off the eastern end of Matagorda Bay, there is a river steamer that could very well be the very one pictured in the view of Matagorda. Maps and historic renderings turn out to be really productive.

There is also a view of Indianola from the same period, 1860. We surveyed the port area and found the warves. They had railroad rails on them to aid in loading and unloading the ships. The view of Indianola actually shows a shipwreck. There's a little part of the remains sticking out of the water.

The view of Indianola shows a vessel that is now a wreck in the Navidad River. We're virtually certain of the identify of this vessel because of the unusual design. It's an eastern rivers steamboat design. It doesn't look like

a typical western river steamboat at all. It's got an iron hull, and it was built in England in pieces and shipped to South Carolina. It was the third or fourth commercial steam vessel in operation in the *United States*. It was called the *Mary Summers* and started life on the Savannah River. It ended up here in Texas renamed and refurbished as the *United States* and now has been studied by the Corps of Engineers, since they're going to dredge the nearby channel.

We did our in-bay work from a small craft with a differential GPS system. Positioning from satellites is something that's come along recently. It's very accurate. It's been developed in the last few years, really, and has eased our logistical load tremendously in archaeology. For just two, or three, or four thousand dollars you have an instrument that provides the kind of guidance and data recording that we need for archaeology, that just ten years ago would have been a \$70,000 instrument, and would have required us to set up microwave radar stations on shore, pick them up every day, put them out every day. We're just so thrilled with this new technology.

We had two computers that we used to record our data, donated to us by Compaq Computers. In the summertime down in the hold of that boat was not a pleasant place. But, in spite of being in a somewhat protected area, we did take a rogue wave on the first day and splashed about a quart of salt water on one computer. And the people at Compaq really were amused by this, because when I had it fixed at the end of the summer, all it needed was a new keyboard. They really liked that. And I thought it was fried. I thought it was totally fried.

A lot of manual data-analysis goes on in the field, but we also will be doing automated analysis since we recorded all our data by computer. But we had to review the data in the field so we would know where to do our test excavations. We did the survey in Pass Cavallo from our agency research vessel, the *Anomaly*, which is a 34-foot crew boat. The magnetometer sensor was towed behind the boat for miles and miles, for miles and miles of electronic survey.

After doing the electronic survey, we selected about three dozen of the most important-looking readings from the magnetometer and prioritized those for our test excavations. Almost always in Texas, the historic shipwrecks are covered with sand, so we have to send divers down and do some digging to determine what is the cause of any given magnetic anomaly. And, naturally, not only does it result from the iron in the anchors, the cannons, the chain, the fastenings on a shipwreck—any kind of iron causes a distortion in the earth's field, or a magnetic anomaly—but also from every 55-gallon drum and every coil of wire rope. So, 80 percent of the magnetic anomalies are modern iron garbage and we have to dig to find out which ones are which.

Our diggings are, of course, guided by our knowledge of the historic records and, to some extent, there's an art to interpreting the magnetometer data. If you study it for enough years, you get a feeling which ones are better looking anomalies and which ones aren't. And, as it happened, the first anomaly that we dug was the *Belle*.

We also had students looking at sites like this historic turn-of-the-century hotel out on piers at Port O'Connor. There's one of the pilings still there. We did some mapping of that site with students. We surveyed the beach of Matagorda Island, and recorded the wreck of the *Darlington*, a concrete-hull ship from earlier in this century. I want to record all the archaeological sites, all the shipwrecks.

We began our test excavations using scuba divers. At the anomaly that we dove on first, we found some cast-lead shot, and that looked pretty good for a historic wreck. Not many people use lead shot in their weapons any more. The next thing was a brass buckle of a design that looked a little earlier. And the third thing was the cannon that many of you saw last night. That was the giveaway that the site was the period that we needed to find for the *La Salle* ship. So the first morning we knew we had *La Salle*'s ship.

Now, that sounds pretty easy, but remember we were expanding a search area from 1978, when we worked two-and-a-half months and tested twenty-four anomalies—found some historic wrecks, but not *La Salle*'s. So it was really the twenty-fifth anomaly that we were testing.

We've dug only a very small part of the vessel. It's extraordinary for our Texas waters because there's a lot of organic preservation below the sand and mud. We've got substantial hull remains. There are barrels still stacked in the hold along with the cannon. There's a copper cauldron and other kinds of things that indicate a galley area, perhaps. There is a large area of small lead shot of different sizes.

It's an absolutely mind-boggling site, being in protected waters and having the organic preservation. It's a very fragile site. We covered it back over with sand at the end of the field season to protect it. We were fortunate that the Texas Historical Commission received a grant of \$30,000 from the Houston Endowment to set up security between the end of our work of last year and when we could begin our excavation in the spring.

Marine Sonics Technology, a company owned by a gentleman named Marty Wilcox, has a new 600 megahertz, superhigh-resolution sidescan unit. We were fortunate to have him bring his prototype to our site near the end of the season. If you look very carefully at the images, you can even count the frameheads in the side of the ship. The cannon had already been removed at the time the sidescan survey was done.

The vessel was in the neighborhood of 80 feet long, and we only scratched the surface of the area where our test excavation was done.

We began processing our artifacts in the field, then brought them right away to the conservation laboratory at the Corpus Christi Museum of Science and History for stabilization and cleaning.

I have to say a hardy and grateful word of thanks to Kingfisher Marine Services for loaning us the barge and the drag line to pick up the cannon.

The cannon has an insignia of the admiral of France and of King Louis XIV that dates it to the appropriate period. There is a lot of intricate decoration. Here's a closeup of the admiral's crest. The Count of Vormandois was in office as the grand admiral of France from 1669 to 1683, just the year before La Salle sailed. So, although there's no date on this gun, that gives us a period of time that's appropriate.

The count became admiral when he was two years old. He was the illegitimate child of King Louis XIV.

The lifting handles were cast very commonly on the cannon of this period in the shape of leaping dolphins, and the handles continued to be called dolphins in even later centuries, when they had become just plain lifting handles.

When you remove artifacts from a shipwreck, you have to be prepared to immediately conduct conservation. Bronze is fairly inert, but other things—iron, and particularly organic remains—if you don't treat them immediately, keep them wet, and treat them appropriately, they will fall right apart. So the work in the conservation laboratory is equally important to the discovery and the careful scientific excavation in the field.

One of the staves from a wooden cask was marked number 5. There was a wooden bowl, and to us here in Texas, finding this kind of organic artifact is just such a thrill. It's so rare. There was a pewter porringer, a small dish. There were also a quantity of trade goods for the Indians such as rings, bells, and straight pins. The heads of the bronze straight pins were made of a piece of wire twisted around.

La Salle's personal gear was on this ship. The set of navigational dividers might be a candidate for something that might have belonged to the great man himself.

The bells were used in falconry in Europe and were used for decorating the clothing of the Indians. So they were highly desirable trade items. A lot of them were still wired together in pairs. For falconry they were used in pairs, and the musical notes of the bells were made to be intentionally half a tone apart because when they jingled that way, you could hear your hawk farther away.

Glass beads were also items of trade with the Indians. There were also intact pottery vessels, a strainer, and pewter serving dishes. Some of the pottery vessels actually had their contents intact. The white ones are French faience. It's a particular type and style of ten-glaze pottery that was another of the main clues that this was the *Belle*.

There was a whole stack of pewter plates. They had a very interesting French touch mark, and the initials of the owner on the back. The initials were those of the *Seur Le Gros*, one of the officers on the expedition who, while out hunting on Matagorda Island, was struck by a rattlesnake. After three months his wound went bad, and they decided to amputate his leg. Unfortunately, the surgeon had never done an amputation before, and so he died in agony three days later.

One of the really interesting clues about the *Belle* was from the Spanish. The expedition that found the wreck said that the *Belle* was a virtually new vessel. I was corresponding with my colleagues in France this summer, and they came up with naval lists of construction. The *Belle* was a very common name.

And there were two or three candidates for the *Belle*, one built in the 1660s, one in 1683, and then a couple of others in the same general period. But the Spanish telling us that it was an almost new ship helped us identify which *Belle* it was. So we know where it was built and who built it, based on that offhand comment in the Spanish account.

The way all these pieces come together to form a story and help you identify a shipwreck as a particular shipwreck is one of the most exciting and important things that goes on in my work. It's really a thrill.

Bill Moyers: Why such passion for such a minuscule sliver of the historical path that we've taken?

Barto Arnold: Well, you mentioned in my introduction, and I started out training to be a land archaeologist, a prehistoric archaeologist. But the reason I shifted over to archaeology of the historic period is that a handful of arrowheads or flint flakes doesn't tell you much about the people that made them. But when you're dealing with the historic period, you have a chance of finding some clues in the historic record that help you make that personal connection with the past. It sends chills up and down my back, you know.

Bill Moyers: No, I wouldn't ever guess it. Bob?

Robert Ballard: Yes, I have two questions. I certainly know that in my work, even though I'm out on the high seas and away from all sorts of

people, that on a very accelerated basis, certainly when I went to do the *Lusitania*, I've been finding a more and more litigious world entering the deep sea. My first question is, since this was an official ship of the French government, have the French claimed it? Because war ships are forever the property of the nation.

I know that when I found the *Bismarck*, there were two Germanys at the time and I was curious which Germany was going to claim the *Bismarck*. West Germany informed me that it was their ship, and they barred me from going inside. Yet, when I found the Japanese battleship *Kirishima* we did not hear a word from Japan.

What did the French have to say?

Barto Arnold: Well, this wreck is easy because the king gave this ship to La Salle as a gift. So it was private property. And you're right about the rights of naval vessels staying with the state. In Texas, we've got—I'll get Joe McKnight to explain this. But we've got a little different situation here in Texas since we went through a phase as an independent country, those sovereign rights devolved upon the Republic of Texas for ten years. And so the State of Texas claims it as sovereign prerogative, even if it was a naval vessel.

Robert Ballard: A follow-up before I ask my second—what percentage of your budget is for lawyers? I can tell you that a good 10 to 15 percent of mine is.

Barto Arnold: We had an eighteen-year-long lawsuit with the treasure hunters over one of those Padre Island wrecks, so that will give you a clue.

Robert Ballard: As you plot your strategy for follow-up years, particularly knowing the hull is organic, and knowing the sad examples of people bringing up the hull, and the tremendous amount of energy needed to preserve them, is your strategy to deal more with the contents than the container?

Barto Arnold: No, actually, we are going to bring up the hull. We're going to disassemble it. It'll be easier to treat in that way. And if it was a big ship, I wouldn't contemplate doing that. There's not a successful way to preserve a big wooden hull. The *Mary Rose* is having trouble. The *VASA* is having trouble. But this is a small ship. We can disassemble it, and it'll be easier to impregnate the wood that way.

Robert Ballard: But after you take the contents.

Barto Arnold: Yes. What we're going to do is build a cofferdam and pump it out, because the visibility is only inches in the bay. And we'll do much better archaeology that way.

I think that instead of working down, we'll work in from the side and that way the parts that are buried in wet sand will stay buried in wet sand, and we'll disassemble the hull as we go across and excavate the contents a little bit in advance of that.

Bill Moyers: Did I hear you refer to Texas as having gone through a short period of independence?

Barto Arnold: Well, remember archaeologists think in hundreds and thousands of years.

Bill Moyers: I have to say, before I turn it back to your president, that when I hear these former landlubbers talk so passionately about their work, I am reminded how brine is to the sailor's lip what ambrosia is to others.

There's a little ditty that I came across called "*The Sailor's Consolation*," in which one old tar at sea, in the midst of a rising storm, says to his mate, who happens to be named Bill: "Ah, nor'wester's blowing, Bill. Hark! Don't you hear it now? Lord, help 'em. How I pity 'em. Unhappy folks on shore now."

William Crook: We're going to break in just a second. Elspeth Rostow has asked that the committee studying the purpose of this Society meet with her in the back of the room during the coffee break.

We've taken a little of your time in the coffee break, but I'll tell you what I'll do. If you'll give it back, get your coffee and come back, I'll cut the business meeting that short. The business meeting is important. We hope you'll stay. We've tried to plan this so we don't feed you too much. We think—well, what do you think so far?

Have your coffee and come back as soon as you can. Tonight, don't forget, if you're going to drive out to the house, talk to someone first, get the map and instructions, because time is going to be very limited.

SUNDAY SYMPOSIUM

William Crook: We're going to have a very brief session this morning. I know many of you have long drives and planes to catch.

I want to tell you a sad thing, and that is we're losing to retirement Colleen Kain, who has served this Society so long and so well. But the Board, in its session yesterday, or Friday, made her an honorary member of the Society. Colleen.

And the good news is that the very efficient young lady who's taking her place has had time to study under Colleen and is going to serve us well in the future—Evelyn Stehling. Evelyn.

Now, I am a lame duck this morning. We have a new president and I want to introduce him to you, although you already know him. But one of our most distinguished physicians and administrators in the state, having headed up the Southwestern University Medical School, and later the Foundation—Dr. Sprague, would you stand? All right. Bill Moyers.

Bill Moyers: Thank you, Bill.

As Bill said, we're going to have a brief, but, I'm sure, lively session this morning. For the first 15 minutes, we're going to let the panel talk among itself about a question that I will put to the group in a moment.

Some years ago, Oliver Edwards wrote a letter to Samuel Johnson to confess, "I've tried in my time to be a philosopher, but cheerfulness was always breaking through." Now, to the dismay of the moderator, a lot of cheerfulness kept erupting among our scientists yesterday. And while I like the taste of it in the air, I am, as a journalist, skeptical of its nutritional value in an age when our failure to confront reality can lead to a more painful reality for coming generations.

Lyndon Johnson once reminded me of the urgency of bad news: "Remember how Napoleon instructed his secretary. He said if the news from the front is good it will wait until in the morning. If the news from the front is bad I want to know about it instantly."

I think there's something to that in regard to our present exploitation of the natural resources of the world to satisfy our gratification now. As a journalist I don't think that our optimism is justified. When I was born 61 years ago, the population of this country was 130-some-odd-million people. It's now 250 million, often quite odd, people, and growing.

The front page of the *New York Times* just this week had a story about how several corporations working together had managed to cut significantly the amount of pollutants released into the air. But, the article went on to say that 700 Ford Explorers on the road—700, half of the daily output of Ford Explorers—more than offset the gains that had been made by the

corporations that had voluntarily collaborated in cutting emissions. Now imagine a billion Chinese in Ford Explorers!

All this adds up to pressures on the ecology. That suggests to me that human activity is more likely than not to overwhelm its habitat sometime in the course of the next century.

And so my first question which we will talk about is this: On the basis of what each of you know from your own research and your own study of reality, if present trends continue, what is going to happen? Mary?

Mary Altalo: Bill, you've posed a very provocative question as usual. The reality is that anthropogenic input is causing a great variation and variability in our system. And the variability and the trends are not in a good direction. Estuaries are becoming polluted. Estuaries which once had oyster populations in the bottoms, such as the Chesapeake, which once had a lot of spawning stocks within estuaries, within their basins, now no longer hold those. They no longer harbor these because they are affected by the pollutants which translate to higher biomass, higher degradation, and often anoxic bottom waters.

There is a frequent increase, along the shorelines in particular, of noxious growth of seaweeds, algae, sea grasses, which are clogging a lot of the estuaries, a lot of the transport rivers and tributary estuaries.

There are pollutants in the sky. We look at Los Angeles. We look at any of the big cities. We see these right there. There's just no question.

Heat—thermal pollution. Thermal pollution from power plants, thermal pollution from a number of different areas is truly raising the temperatures of the near-shore surface waters, raising the temperatures of the atmosphere. These are not leading to good trends. Animal populations are decreasing.

One of the things that I think is very, very difficult to understand is that places—like the National Biological Survey—which are now poised for looking and maintaining and identifying these populations, are all looking at the terrestrial component. They are not looking at the marine component, and we've got a diversity of wealth. There are populations disappearing every day and species disappearing every day in the near-shore surface waters we don't know about, we can't monitor.

The reality is we know how to fix it. I truly believe this. I've shown you all the technology. The technology is there. The solutions are there. We put these together on a global basis. And in certain localities they are choosing to fix it. The Chesapeake Bay has been a wonderful, exquisite example of how, when the states cooperate, and they've gotten together, they're actually able to put a moratorium on dumping of certain types of pollutants which are harming the estuaries. And they are coming back. The Chesapeake Bay is one of our success stories. And there are a lot of local success

stories. But, in general, these are the minority and that's what concerning me.

The reality is, like I say, it's happening. We know how to fix it, but we're not choosing to as a nation. And that translates into the monetary problem.

Wes Tunnell: I am reminded of what's happening in the world fisheries. We didn't really address this specifically during our time of discussion. There was a wonderful article in *National Geographic* this last month—some of you may have seen it—on the world's diminishing fisheries. And if you read through that you saw that 1989 was the peak of fisheries in the world, and we've started to decline now. There's lots of variation and variability in that, and certain places are worse off than others, but I think that's a real signal or a sign to—we've got to start doing things differently.

We have the tools and techniques, as Mary is saying. We have to do something new in our management ways to educate the public in what needs to be done. And there's often times in the new marine sanctuary areas of the world that we want to self-regulate ourselves. But if we look at some of the crashed fisheries in the world, we see that self-regulation doesn't work, that regulation has to be imposed.

I have experienced personally, in our new Environmental Science Bachelor's and Master's degrees at our university, a trend there that the young people are eager to learn and apply environmental science to our world. We often get into discussions though about mom and dad and grandma and grandpa who keep saying, "I didn't do it that way. We didn't do it that way. I don't know what they're talking about. We don't need to do these new things. We didn't have to do them."

But it's this realization of the number of people on the earth and the pressure that they are causing. If we go to our young children, in elementary school now, we see that they're more cognizant of environmental science than the mothers and fathers and grandmas and grandpas. They're the ones who are really making the older ones recycle the trash, turn off the water, do all these kinds of things. And so it's a generation away, I think, where we have this new mind-set on how to manage the environment.

Bill Moyers: But they're not running the cruise ships and they're not running the liners and the oil tankers at sea from which so much of the spoilage is now coming.

Wes Tunnell: That's true. But they will be. Can we last until then? That's a good point.

Bill Moyers: We'll last, but will the damage be irreversible?

Wes Tunnell: In some places, I think it will be. We've seen some places though, even in our own state, like the Houston Ship Channel—when it

caught on fire in the late 1960s we decided something was wrong with the water. And so we came up with some new laws to clean up the water there now. And people were even catching fish in the Houston Ship Channel. Now, I don't know if I'd eat them or not.

So the technology's there to do it, but we have to do it.

Robert Ballard: I've spent a lifetime away from society exploring, and I must say the question that you posed is the one that bothers me the most of anything I ever think about. I'm deeply concerned about where we're headed. I know the human race is one of the most adaptive species that's ever been brought onto this planet. I certainly saw that when I was in Beijing.

When I grew up, I was led to believe that I was going to escape Earth and that I was going to be like Superman who left Krypton just as it went up in smoke, and that I was going to live on Mars, and I was going to swim in the canals of Mars and I was going to grow tomatoes on Venus. But I'm not going to do that, nor is my son, nor are his children or their children. Space is not an alternative in the time frame that we need to address.

But it's very important that we, in the ocean, don't create another false prophesy. That we're going to escape the land and go to the sea. I've spent a tremendous amount of time down there. I would consider a penal colony down there cruel and unusual punishment.

So I'm deeply concerned about where the human race is headed. I do think the oceans will provide some relief to population growth, but not a great deal. If you look at the amount of ocean floor that receives the sun's energy, it's the size of North America, 24 million square miles.

But most of that land is in high latitudes. It's in the Arctic. There's not much real estate—except in the area of Indonesia—that's near the equator, that receives the sunlight.

There's no way people are going to live beneath the sea. It's totally ludicrous. The ambient pressure—it takes an outrageous number of people to support one individual under water at ambient pressure. So we're not going to live under the ocean. We're probably going to move out on to it, probably wanting to keep land in sight.

But the oceans do not hold out great promise for the population, certainly not in terms of feeding it. We've already taxed that to the limit. We're moving away from a hunter-gatherer society. But even if we were to manage it better, the sustainable yield would increase, but certainly not to hold off the Armageddon I think we're heading towards.

So I think the responsibility of every intelligent human being, regardless of their discipline, is to force our system to address the issue. We're creating too many people.

I think the most important step we can take is the empowerment of women. Empowering women, giving women control over their lives. We always thought you had to pass through a developed state as a nation before you could crack the birth control problem. But now we're seeing that you don't, that third world countries with proper education and proper empowerment of women are having a significant impact on their population.

Tony Amos: Well, I had expressed some optimism yesterday, and I want to clarify. My optimism, in particular, was to do with the problem of marine debris, solid-waste marine debris. And I believe there is an improvement, both in attitudes and the amount of material being dumped into the sea.

But, overall, I'm not optimistic about what I see in the continuing development of our coastal environment. And here is a good case in point. We are continually being asked to comment on various projects to raise causeways, to make channels between islands, to improve this, to improve that, by big engineering projects. And what I see as one of the problems, maybe they will do what they set out to do, but they will also encourage continued development of the coastal environment, a sort of domino effect.

Continuously we have little parcels of land which are taken over, and developments are put on them, and it is a situation which I think has obviously got to stop. I mean, look at the island that I live on, Mustang Island. It's essentially been written off. At one time it was considered to be a kind of uninhabited island, except for the town of Port Aransas on the north. But essentially that's written off, and eventually it will end up with wall-to-wall condominiums. And that's got to stop somehow. And one—of course, what Bob has said—one of the reasons is that we've got a continuing population explosion.

What bothers me, however, also, is an attitude change I see occurring in the country, an anti-environmental attitude that is growing. And that really bothers me. I'm considered to be an environmentalist here, and when I get asked to comment, one of the things that I have to say is that I am—yes, I am anti-development. I think we have to stop that, or at least control it. We just can't continue on doing it. Therefore, I might be against a project simply because it just adds another piece of concrete here, and takes over another little piece of land there that most people consider to be wasteland.

So I'm a little—I'm certainly concerned about the continued development of our coastal resources and somewhat pessimistic in that sense.

Barto Arnold: Shipwrecks aren't a life-and-death issue like over-population, but they certainly are an area where you can see the problem with attitude and character that people have. Historic shipwrecks are a severely limited resource, like natural resources are limited. And if you look at a

place like Florida, where commercial treasure-salvage has been a way of life for a long time, almost every shipwreck in Florida has been damaged or destroyed by people looking for treasure, mostly non-existent treasure.

So it's an attitude of trying to get something for nothing and the seductiveness of the idea of getting something for nothing. As a result, our heritage is being destroyed. That's not as bad as the whole environment being destroyed, but it is symptomatic of the problem.

Bill Moyers: Thank you. Amy Freeman Lee had to leave this morning to go back to San Antonio and raise hell. But she left a question, which I'll read while someone moves to the microphone. She asked, "How do you explain the salient paradox in our society? We claim to respect science, yet when science substantiates something we dislike, we ignore it."

Robert Ballard: We're human.

Bill Moyers: We're human, but . . .

Robert Ballard: Sometimes you kill the messenger when you don't like the message.

Tony Amos: We have an example of that here in Corpus Christi. We're getting into a problem with ozone. We have ozone-alert days and we need one more day in the next year or so to go above a certain level, and then we'll have restrictions imposed upon industry and the general public. I think that a lot of people don't believe in ozone. They don't think there is a problem. They argue, "Hey, wait a minute, ozone is good up there but bad down here. Explain that to us."

In some cases, scientists haven't explained that well to the people. Because it's an imperceptible change, such as the gradual warming of the oceans and the atmosphere, the public in general often doesn't believe it. And there are forces at large which encourage people not to believe it.

Jerry Supple: I'm Jerry Supple. And the question I have relates to the capacity of the oceans to solve some of our problems. It is 71 percent of the surface of the earth. It has a huge biological and chemical potential for us. I guess the question I would like to ask relates specifically to greenhouse gases. What are the mechanisms by which the ocean can participate in solving some of that problem, and do we have any sense of its efficacy or capacity to do so?

Mary Altalo: Let me tell you about a project that was actually proposed a number of years ago, and which I think demonstrates very nicely the

interactions between the ocean and the atmosphere. And it was proposed by a late colleague of mine whom we miss dearly. But one of the aspects of greenhouse gases and warming is the excess carbon dioxide that is essentially building up in the atmosphere.

Now, it is known that large concentrations of phytoplankton in surface waters will actually draw down the carbon dioxide, take it out of the atmosphere. What it does is that the algal cells are depleting the carbon dioxide in the water, in the surface waters. This creates an imbalance at the surface. Thus, it causes the CO₂ in the atmosphere to get sucked into the water.

So it was postulated by the late John Martin at Moss Landing in Monterey that if somehow you could increase the productivity, the growth and production of these phytoplankton in the surface, they would photosynthesize faster and faster. They would use carbon faster. They would draw down CO₂ faster. And, therefore, you could regulate the atmosphere.

One of the ideas that he proposed was that the surface waters of the open ocean—the reason why you don't have major, major blooms of phytoplankton or high concentrations of phytoplankton is because they're growth limited, not by light, not by carbon, but by a few trace metals that they can't get because they're so far from the bottom.

The limitation in open ocean water is iron. So it was postulated, and the experiment was called IRONEX—it just started about a year ago—that if you took the ocean, a certain portion of the central ocean, and you flew planes over it and you dumped some iron into it, that all of those surface populations would use the iron and start photosynthesizing like crazy and draw down CO₂.

They flew the campaign. They dumped the iron. The water in that area turned green. Green means you've got lots of photosynthesis, lots of organisms going on. And the surface concentrations looked like, in an effort to get gas exchange, the flow of CO₂ was going in versus going out. So those are the kinds of experiments and those are the kinds of things that I think are really illustrative of the problem of using some of these innovative techniques. It's the mechanism that we know to be able to regulate the flow in the right direction.

Now, the prospect of dumping iron all over the ocean is a real tough thing. But it was a tremendously innovative experiment, and it has just pushed our understanding and our—it has empowered us to realize that, yes, we maybe can do something about it.

Liz Carpenter: Well, I think that I'd like to know if the Pope has an outspoken environmental advisor to advise us, in view of the danger. How much effect could it have to allow birth control around the world? Such a

lot of people have been making that point forever. Does he have anybody laying out these facts?

Robert Ballard: Well, to my knowledge, half the population of the world is in China and India, and there aren't many Catholics there. So, clearly, it's a global issue that all nations, all religions, have to deal with. And certainly the Catholic Church would be helpful if they would move a little forward on that issue.

Liz Carpenter: Do you know if he seeks information on this, if he has an advisor?

Robert Ballard: I don't think he can avoid it.

Ralph Shuffler: He does have advisors. He has a really big school of scientists that has recommended, at least since 1945, that the church not act the way it has. I'm not a Roman Catholic, and this is one of the reasons I'm not. Yes, they do have, and they haven't followed recommendations by top-flight people over and over and over again. But the Congress of Scholars must come out on the side of natural law. I think it's a peculiar reading of St. Thomas.

Tony Amos: Bill, could I make a point?

Bill Moyers: Yes, Tony.

Tony Amos: This is what Mary said. The amount of iron that would be needed to do this experiment would be tanker load after tanker load. And I think that we have to wonder. It's an innovative and extraordinary suggestion which has great merit. But I think we have to be worried about these kinds of big schemes to overcome problems that could be stopped, perhaps, at the source instead of trying to fix it after it's already broken.

One way would be to, perhaps, let us get some alternative ways of transporting ourselves around by using alternative fuels, to oil. It happened in the 1970s when we had a crisis, and there was a lot of innovative research done. The motivation to find alternative fuels slowly and inexorably disappeared as we seemed to have an abundant supply of oil. I think this is one of our major problems we need to solve.

Mary Altalo: Can I just really briefly respond to that? Tony, I do agree with you. What I was trying to do is be illustrative of a concept of the exchange between the atmosphere and the ocean, not necessarily saying this is the

best way to fix it, but meaning that there—as an internal sort of a vision of a story that shows the interactions.

Steve Weinberg: I'd like to offer a partial answer to Amy Freeman Lee's question and see if the board has any response. The reason why people don't accept the view of science about what's happening and what could be done to affect it is because there's not much of an incentive to. Even if you were concerned about the environment, if—I may be very concerned about the environment, but if I add one more vacation home on Mustang Island and move into it, just by myself, not holding myself up as a model for everyone else, I haven't really damaged the environment so much. And then I can move in and call myself an environmentalist and oppose other people moving in.

Likewise, if I'm a cruise-ship operator and I decide that I won't be entirely careful with my wastes, I'm not going to add that much pollution to the ocean. It's all those other ships that do.

I think the only answer to this is not to teach people about what's wrong and what can be done about it because they won't have any incentive to do anything about it. The answer has to be regulation—Government telling people what they can do and what they can't do. That's not an entirely popular point of view these days. But I think we have to return to it in many of these areas. I would not say this about birth control. I don't like what the Chinese do about that. But, even there, Government can perform a valuable function of education.

I'd like—you know, we've been discussing all these things that have been going wrong. I haven't heard any discussion of concrete proposals for what you as a Congressperson or as a citizen would do to try to get legislation passed that would control these activities.

Bill Moyers: Let's have some specific responses from the panelists. I'd like you to tick off some things that you think are environmentally desirable. Tony?

Tony Amos: Well, one international agreement that has been ratified by most countries is what is called MARPOL (that's for marine pollution). MARPOL was first enacted and agreed to in 1973, I believe, and there are several annexes to MARPOL. One is the control of radioactive waste at sea. One is the control of petroleum products. One is the control of noxious chemical products. And the most recent one is the control of solid waste, in particular, plastics, into the ocean.

Many countries have agreed to MARPOL. Unfortunately, here on the Gulf of Mexico, some of our neighbors have not. One of our neighbors in

particular, Cuba, has not responded to that. But it is a successful international agreement. However, the problem is enforcement. And enforcement is very difficult. Habits are very difficult to break, too. Just on a small scale, when I go to sea. Although smoking is not condoned very much anymore, a lot of people still smoke. And you will see people who will be environmentally astute flip their cigarette butts right into the ocean as a matter of course. And habits like this—the use of a styrofoam cup, for example, to drink one cup of coffee and then throw away. These are habits that could be changed for the better.

Barto Arnold: As a possibly more popular alternative to new restrictive regulations, you could alter the government policies that are counterproductive. And shipwrecks are just an example of how that has worked out.

Prior to the enactment of a federal shipwreck law in the mid-1980s, the admiralty jurisdiction of the federal courts imposed commercial treasure-salvage on the states, regardless of what the state wanted to do with its antiquities code. Rather than trying to outlaw treasure hunting, which we would have preferred as archaeologists, we drafted the law to remove the historic wrecks from the jurisdiction of the federal courts and leave it up to the states to decide whether to have treasure hunting or not.

At least we've eliminated a big negative influence, even though we couldn't impose the positive influence we wanted.

Robert Ballard: Mine is to commit myself, as I have done, to educating young people and to educate the general public. I'm amazed when most people say they know so little about the deep sea. Ninety percent of what I talked about has been known for twenty years.

And so, clearly, there is no major institute in the United States that commits large resources towards educating the general public about the deep sea. They have a completely ill-conceived notion of what most of our planet is all about.

And until they realize that the vast majority of our planet is a wasteland—an uninhabitable wasteland—they cannot realize how precious that little part of it is that sticks up above water, and understand that the universe has collapsed down to a very, very small amount of real estate that we are pouring concrete on and asphalt on.

So I think we must commit ourselves to just making everyone on this planet literate about their planet, so hopefully they'll stop littering it. But I think that's what we can do in the position we're in. We certainly would ask our politicians to be braver, ask our media to be less biased and present facts. I always enjoy going to England and watching the BBC when they announce the person who's going to tell the news as a reader, not as a

giantly significant personality. And in the BBC, they say, "Our reader of the news today is Joe Blow from the Alamo." And this person is reading the news as opposed to interpreting it.

And so I think our job is to present the cold facts in non-politically correct context to intelligent people so that they might be able to make some intelligent decisions.

Bill Moyers: In that regard on the media, just a quick response. The media is not . . .

Robert Ballard: I thought that might happen.

Bill Moyers: No, no. I'm on your side in this, which is why I am in public broadcasting, not commercial broadcasting, because commercial broadcasting long ago made its peace with the economic rules of the game, the little lies and the fantasies of merchandising. But it's a dance between the media and the public, as it is in politics. We want to blame our leaders, when the public often negates what the leaders want to do. We have been unable as a nation to implement the Rio Accord on emissions to the atmosphere, one of the few major democracies that has refused to do that, because of the strong ideological bent in our politics right now. So when politicians try to do certain things, the people resist.

In regard to the media, most people prefer to watch entertainment than to watch information and education from the media. It's one thing to get funds to do exciting documentaries about exploration underneath the sea, but almost impossible to get funds to do important documentaries about the threats to the seas.

We have wanted to do for years a major series on the Gulf. I've seen public television documentaries on the Aegean, on the Mediterranean, on all the exotic distant locations, but never a single documentary on the Gulf Coast.

I once heard William Buckley say that democracy cannot be successful unless it is practiced by politically mature people, among whom there is a consensus on the meaning of life within society. We don't have that consensus right now. It's easy to blame the politicians, and they are to blame for part of it. They're caught up at the moment in such expensive campaigns for office that money from their contributors dictates policy much more than scientific reality dictates policy.

How do we create a new consensus? How do we create a new consensus about what it takes to survive as a society?

Ralph Shuffler: I would like to both ask Dr. Ballard and affirm what you've just said how difficult it is to get anyone to agree on anything and also

actually to follow through and do it in a democratic society. You were waxing eloquently about breaking through the media with the new media of the information highway and being able to talk back and forth.

It really scares me to death, because the Transnational Corporations—including Liz's whipping boys in the Catholic Church, and the media's whipping boys in Columbia—have been extraordinary pirates in all of our experience. People have called corporations "persons without a soul," I believe. It looks to me like they are voracious.

And if they're making money selling dope out of Columbia, or making money selling whitsets out of San Antonio, Texas, and doing it on the internet, we're in deep mudd—*not* an easier place. Would you all have some kind of comment about that?

Robert Ballard: Well, I think history is full of examples of the emergence of a technology and its devious use and its wonderful use. Technology is amoral. It's a two-edged sword. Nuclear energy can heat your house or blow it up. Computers can help balance the checkbook or invade your privacy.

Certainly, the information highway is a tremendous technology—where, I understand, by volume, the majority of things moving on the information highway, or a significant percentage, is pornography right now. That is just a reflection of a new emerging technology that will become regulated. It's been an experiment for quite a long time, but it's rapidly becoming a technology that will be used in every walk of life.

I know in my particular case that I drive my car much less than I used to. I'm on the road much less than I used to be. And so it could have a very positive impact upon not putting us on the road as much as we used to be. But, you know, the information highway is being built and it's going to greatly alter all aspects of our life. And the question is in what way.

Fred White: I'm Fred White from Fredericksburg. I'm concerned with attitudinal changes of our population—world population—as a whole in regard to what we're doing. And I'm reminded of the statement of a wonderful philosopher, John Stuart Mill of the last century, when he put forward the idea that communities, cities, have become quite large enough to gain from them that conviviality and security of living together. And beyond that, that it was dangerous for man to associate primarily with his own species, and only his own species, or limitedly with his own species. And does this size of communities—that was important in the sense that it put these communities in a context of association with nature, if they were appropriately structured.

We seem to have lost that. But it's within the human genome, it seems to me, to have an attitude a little like the Bushmen or a little bit like the attitudes of the Hopi Indians, people we've lived with for short periods of time.

And I'm reminded of this from Lawrence Vanderpost about the Bushmen, and I think it's true in describing them. The Bushmen lived in an extraordinary intimacy with nature. Wherever he went, he felt he was known. We're a generation of know-alls, but few of us have a life-giving feeling of being known. Wherever this little man went, he was known. The trees knew him. The animals knew him. And he knew them.

His sense of relationship was so vivid that he could speak of our brother, the vulture. He looked up at the stars and spoke of Grandmother Cirrus and Grandfather Canus because this was the highest title of honor he could bestow.

This flows from our own shared genome. My question to the panel. Have we lost it forever or can we regain it? That gentling aspect of the marvel of association with nature is, to me, the key issue that we're talking about. So I'd like the panel of members to respond to, is it a hopeless thing?

Bill Moyers: Not too cheerful now.

Wes Tunnell: I might respond with a not-so-cheerful answer also. Many of you have heard of ecotourism, and some of you have undoubtedly participated in that, in some wonderful places in the world. And I think that's an example of it's being in the genome no matter where you're from, the wanting to get back to nature. And people discover these wonderful places to go to now. It's unfortunate to see that some of us ecotourists who love to go to places like the rain forest of Costa Rica are now the ones who are killing the rain forest in Costa Rica. We are loving it to death.

And so, again, back to the population thing. There are too many people to be supported in certain kinds of areas—most kinds of areas. Sorry about that.

Patsy Chaney: Patsy Chaney, Austin, Texas. I think that if we ask all of you in this room if you watch PBS, you would probably all say yes. There is another part of media—I suppose we still call it media—called talk radio. And I listen to that a lot, mainly because Mr. James Michener says it's good to listen to Rush Limbaugh because he makes you know what you believe. If you don't agree, then you agree strongly in your values the other way. Mr. Rush Limbaugh doesn't believe in ozone—that it's a danger, that is.

And for all of us that are talking today, I would feel better if you all on the panel would tell me how you're going to educate Rush Limbaugh.

Tony Amos: Let me respond in part to that. First, the thing that Rush Limbaugh uses is ridicule. Now, we do not as scientists. We don't get up here and ridicule things in a direct fashion that he does. Ridicule, unfortunately, appeals to the baser instincts of many of his listeners because they can say, "Oh, yes, you know, femi-Nazis." I listen to him until I cannot stand it any more. But I listen to him regularly because how can you comment on something if you haven't actually heard it?

This is a problem with many of the media things that you see. The 30-second sound byte where somebody will say, for example, "Oh, we have to ban this book because it is disgusting." And then you find out whether they have read it or not and they have not. They've just heard from other media or people like Rush Limbaugh what it's like.

It's very difficult for us, who are supposedly—how can I put it? We're supposedly—we go with a scientific mind-set. It's very difficult for us to reply with ridicule, get down on his same level. Maybe we have to do that. I'm not willing to do that yet.

Peggy Galvan: I'm Peggy Galvan, and I'm a guest at this meeting, and perhaps I shouldn't be speaking at all. But, Mr. Crook, at the beginning, said that this is a very powerful group, and I think it is. And if this group does believe that a wonderful PBS special on the Gulf Coast should be made, surely the expertise is right here, the knowledge is right here. And if it's a matter of money, surely you powerful people have access to funds which could be the seed money, a challenge to corporations.

Mr. Ballard can only visit so many children in school. But tapes could be made from this program, distributed to all the schools. And wouldn't it be wonderful if something really positive came out of this meeting.

Bill Moyers: You certainly know how to pick up a cue, Peggy. Yes, sir.

Jerry Doyle: Jerry Doyle, Beaumont. What is the attitude of the panel towards—or support for—the United Nations Law of the Sea?

Tony Amos: That's a tough one.

Bill Moyers: Yes, that is a tough one.

Tony Amos: Well, I'm in support of those international laws, the Law of the Sea. It's a very complex issue, and I don't claim to know all of it, but

I believe that we have to regulate the international use of the ocean by certain laws which are agreed to by the majority of the sea-going nations and the nations that border the oceans.

Robert Ballard: There was a fly in the ointment, though. And the problem—as I understood it in tracking the Law of the Sea, and certainly our institution and our Center for Marine Policy was heavily involved, and it's been going on for many years—the real bad part of that law was in its effect on corporations that developed technology to exploit the resources of the oceans.

After having expended a tremendous amount of resources needed to mine the gold, the Law of the Sea basically orders the companies to turn over everything that they had done with no compensation. And this is ludicrous. The economic incentive was just taken away, so no one would want a law that said that they would have to spend all the money up front and then have to turn it over to an international body that then could exploit it without them receiving the reward for their incentive. Until they change that, it's just not going to work.

Tony Amos: However, I have to comment on that. The idea was that the third-world countries would immediately gain by all this effort that the developed countries have put into doing the research on how to extract manganese nodules, for example, from the bottom of the ocean, or ocean thermal energy.

However, it is unfair in a way in that the developed countries continue to have that great advantage because of their great resources in exploiting an area that belongs to everybody.

Robert Ballard: But I think we've seen that in any exploitation of a resource. It's called royalties. There's ways in which compensation schemes can be devised to compensate a world body for the access to these resources. We have this all the time on federal lands. Maybe we could argue that there should be much higher royalties paid.

But unless you begin discussing such a concept, some form of compensation as opposed to nothing, you can't have much of a dialogue.

Question: [Speaker not at the microphone. Unable to transcribe.]

Robert Ballard: No. But that's what's got to be worked out. There's got to be a reasonable economic incentive to invest such large amounts of money. As far as I'm concerned, any natural resource is a common resource of the

planet and not of some specific group. But when you then ask a specific group to extract it, there must be the economic incentive to make it fair.

Tony Amos: None of these third-world nations that wanted the information had the ability to exploit those resources anyway.

Robert Ballard: But you would assume they would be the recipients of the royalty.

Tony Amos: Yes, but they would have had to have cooperated with the developed nation such as ourselves in order to extract that.

Robert Ballard: But therein lies the rub. And that's the problem, is that many countries cannot do it. Only a few can. And I believe it just has to get worked out.

Alec Rhodes: My name is Alec Rhodes. One of the initial questions you gave us, Bill, the one left by Amy Freeman Lee, was, in a society where we purport to believe in science, we ignore that science in our actions. And if we do that—and I'm making a statement, I'm not asking a question. If we do that, it's because it is to someone's best interest. Someone has a vested interest in doing that. And there is interest either individually or collectively for us to take these other actions, many times to the detriment of the environment and the sea.

If we as society permit that, it is at least in part because of what Mr. White from Fredericksburg just pointed out that we have lost touch with our role and our relationship to our environment.

I submit that one of the failures of science is to relate the body of knowledge, to relate what you know and what we know in this room about our environment and about our world to our local communities.

There's a bumper sticker out there that says, "Think globally and act locally." There's a lot of truth in that. And our failure to relate this world to our individual lives and our individual communities is part of why we, with impunity, take actions which hurt us collectively.

If there's an answer, at least part of the answer—we can't do what Steven Weinberg would like for us to do because we're still a democracy. We have to—we can't just regulate unless we believe in these precepts. And Robert said earlier that one of the findings he found that he believes in is the empowerment of women, for example. That's an education process.

Much of what is going to help us here is for us to educate people about what it means when we damage the environment, not just the ozone layer or the ocean, but what happens locally or anywhere in the world—the fact that we are related to that.

A good example of this is, even in poor villages in South America—there's a Texas organization called Bats Conservation International which deals with the importance of bats. It's an environmental group that has gone to very poor villages down there and has shown these people the value of protecting the bats because of the effect it has on their crops, and the effects that it has on them locally.

We need to do the same kind of thing worldwide so that people understand the damage that's done and understand the benefits of protecting the environment. And I think our challenge as philosophers and as scientific educators is to do exactly that—to allow people, enable people to understand that relationship and understand the value of what you're doing. Thank you.

Tony Amos: May I comment on that? I think, just as there's a lot of debate in the country about how we fund our politicians, how they fund their campaigns and so on, I think there's a problem in the way that science is funded.

If you put in a proposal to one of the big national, or even state organizations, to say that you are going to go down to South America to teach people the importance of bats, the chances of you getting funded would be very slim. So maybe there should be other funding sources that would fund such programs that are really educational, and maybe our attitudes towards funding science should change.

And I think they are changing a little bit, but high-profile scientists who get out to the media are often scorned by their lower-profiled colleagues for being kind of publicity seekers and so on, and we have to change that attitude too.

Jon Fleming: Jon Fleming from North Zulch. Some people have wondered what North Zulch is. It is to College Station what Dripping Springs is to Austin.

This has been a delightful meeting, and I suppose this question is going to go to Mr. Moyers, or perhaps Mr. Crook, as the distinguished former ambassador.

Buckminster Fuller used to refer to our planet as our spaceship, and I don't think any one of us would disagree with that notion. And we have this spaceship with clearly limited resources—as the panel has pointed out to us, some of them are replenishable, others not.

Why in heaven's name, with that knowledge, can't the G-7 come to a point where we use our economic clout, our technological exports, our medicinal capacities, all of that, to bring the other parts of our spaceship into line on the subject of population and abuse of the environment?

Because if we don't lead, there will come a time when our spaceship is used up and the human race will go away.

I think, as Dr. Rostow mentioned yesterday in her report to us, as a Society, as we begin to formulate an agenda for the Society's meetings with the millennium approaching, that that's certainly something that we could talk about. And we could talk about it creatively. But I have always wondered why, with the tremendous power of this nation and our six partners that lead the world, and we shouldn't be afraid to lead the world, and we shouldn't be afraid to say what is right, and we know it's right. And democracy finally has its limits—that 51 percent of the people finally can have their way and their will in this country, and I would think in the world.

I wish some of you would respond to that because it's terribly frustrating being one of those people that does recycle, Bill, and tries to act responsibly. It's very frustrating for us to live in this way and seeing where we're headed. Thank you.

Bill Moyers: Well, that touches on the question I raised yesterday, which the panel very diplomatically avoided, and I was able to let the clock run out before we got to it. Having been raised a good Baptist here in Texas, I always thought that the human race was the summum bonum of creation. I've begun to consider that perhaps that is not the ultimate aim of creation. Certainly the conduct of the human race, while rich in moments of wonder and wisdom and grandeur and benevolence, also suggests tendencies that may be hostile to its own perpetuity. An Earth without the human race would be an Earth without the Holocaust, or genocide in Cambodia, or slavery.

Question: And a world without Mozart.

Bill Moyers: And a world without Mozart. But there is music in the sea, and there is the music of the spheres of the universe, as Joe Campbell told us. Who knows?

Robert Ballard: We all are churning with these questions. Anyone that's looking around and can see the world has to be churning on these issues.

And it's clear to me that Earth will survive. I've put a lot of effort into educating people about the wonders of our planet. But I've been more focused of late, not on Earth's survival, because I'm assured that it will be around for a long, long time, and that the processes that it has will be around for a long, long time.

But the real issue is us. I do worry about the extinction of species, but I really, really worry about extinction of us. And I think that if we can save

ourselves, we'll inadvertently save everybody else. That's sort of the way that I've come to grips with it. Because to save ourselves, we will probably take the pressure off everybody else as well.

So the question is what do we do about us?

Question: That's what my question is.

Robert Ballard: I think we have to focus on us, not in a selfish sense, but in an actual way of saving everything.

Bill Moyers: We'll let this be our final question.

Fairfax Randall: I'm Fairfax Randall from Houston, Texas. And I sat at Bob's table yesterday, and had wonderful discussions. And he proposed the thought about deferred birth and waiting to have children. And he had some wonderful ideas, and I listened. And I've listened to all of you and loved hearing because it does make you think, and I feel so alive with ideas. And the man from Kerrville said that we've lost our connectedness, and I do feel that one of the reasons we've lost our connectedness is because we say we believe in God, but do we really search for God. And it is my thinking that in the search for God that we do find our connectedness. And this search, to me, is given lip service, but not life service.

And I also want to point out that at our table we talked about incorrect questions and that there would be tombstone that says, No politically correct questions were asked. And I know this is not politically correct, and I know that God is a subject that, sort of, people think, Oh, Baptists, you know. Put that away. Put that away. You know, this is a far-right liberal. I happen to be very pro-choice.

But my question, and it is not to put you all on the spot for an answer because it is totally politically incorrect, is do you think that there is truth in the prophecy of the Book of Daniel that there will be a time of trial? And could God actually be in charge of this Earth and that there will be a thousand years under the reign of Christ and all that died to bring the Gospel to the world?

Robert Ballard: Bill? I read *The Power of Myth* many times, Bill. That's yours.

Bill Moyers: I wouldn't—you want to add something before I think up an answer? Go ahead.

Walt Rostow: Because I do feel from the beginning that there is a scientific element in this which was somewhat missed in the early going. Let's take

this question of South Korea. South Korea has a very rapidly falling birth rate. The fertility rate is 2.1, and South Korea has 1.6. In other words, if it goes on this way, it will come to a falling population. It will peak out, it figured, because of the age of its present population, at 2025, at 50 million.

Throughout the developing world, there's a much more rapid fall in the birth rate than there is here, except in Africa where it's just beginning. Africa is a great trouble to all of us.

My point is very simple. This is, in a way, the good news. The bad news is that the next twenty-five, fifty years are going to be very tough. We can break the environmental bank in that period with the industrialization of India and China. Therefore, we are very close to the period of maximum strain, after which I regret to say to the spokesman here, that we'll all be children of the Catholic Church in a sense, that we'll all be pro-natalist. The only reason we're not a falling population, like the European, Russia, and Germany, is that we're bringing people in from the south.

I, therefore, think that the things you've been talking about will be highly relevant in the next twenty-five, fifty years. And we have to fight the environmentalist issue with food—blessed with energy, as a matter of fact—but with food and the environment and the rest of it. Even then we have no guarantee, if we're stagnant and passive, that we can absorb an industrial India and industrial China into the world.

But after that the population will increase by five billion, up to about ten, eleven billion in these fifty years. And so I would say that in this period where things are going to get tough, the politicians will react to what the panel has to say, what this group as a whole has to say. And we shouldn't give up hope of educating people in the right attitude to survive these next twenty-five, fifty years.

After which our problem, if we get there, will be how do we have full employment in a world which has no population increase. But I'm content to leave that problem, which is a problem of affluence, for later.

In other words, I think that what you've been saying very much applies to the next twenty-five, fifty years. But there are many hopeful trends going on in the world that will help us get through this period.

William Crook: I want to hear Bill respond to the previous question.

Bill Moyers: I don't know if the prophesy in the Book of Daniel will be fulfilled. If I find out from experience, I'll be glad to share it with you, if I'm around in town. No one knows if any "prophesy"—scientific, religious, cultural, or demographic—is going to be fulfilled.

This particular one comes out of a very strong and singular conviction on the part of a devoted religious community. You'll find different kinds

of prophesies on the part of other people who are as equally devoted to their idea of the universe.

As for myself, I know of no other philosophy by which to live in this world than to expect a hospitable future and do everything I can to work toward it. Then we'll see what happens.

I would like to close this morning with just a few words about your president and my friend.

Someone asked me last night at dinner, "Why did you come, knowing so little about the sea? And I said that I'm here for one reason and one reason only—Bill Crook asked me. You know him as your president. I know him not as a president but as a friend. The threads of our lives have intertwined for so long now that there are moments when I can't see but one seamless fabric, and I have shuddered at other times at the thought that that fabric would unravel without him. That's the nature of our friendship.

Francis Bacon said that a man in particular cannot speak to his son but as a father, to his wife but as a husband, to his enemy but on terms, whereas a friend may speak the case as the case requires. That's been the nature of our friendship. Bill Crook has been to me that second self that each of us needs to resist our own impulses to self-delusion and grandiosity.

I'll tell you something about this man I've known for almost forty years. Fontaine said of one philosopher that he knew everything about the universe and nothing about himself. Bill knows himself, and that's been the source of his leadership as a public servant. We were in Washington together. He was director of VISTA, Volunteers in Service to America, one of the most important parts of our effort at that time. He went on to be ambassador to Australia. He never touched a responsibility that didn't become a devotion.

But I also have known him as a citizen. Judith and I spent the best year of our lives in two weeks in 1993 with Bill and Eleanor. We were playing Sancho Pancho to their Don Quixote as they moved through Spain in pursuit of the three caravels which now are docked here in the Corpus Christi harbor. It was Bill's assignment to negotiate with Spanish lawyers and Spanish business people and with Spanish diplomats and Spanish royalty. You should have heard him negotiate with the great-great-great-great-grandson (I hope I got that right!) of Christopher Columbus, Cristóbal Colón, the present Duke of Veragua, who was a key figure in the final decision to allow the caravels to come to Corpus Christi.

It was wonderful to hear Bill think in English and Eleanor translate in Spanish to the Duke of Veragua. And the two of them were the critical agents in obtaining for Texas this permanent reminder of the value of oceanography and marine exploration and of that age of exploration.

So I've seen Bill as a friend. I've seen Bill as a public servant. I've seen Bill as a citizen. And you've seen him as a president. If you feel as fortunate to have had Bill Crook as your president as I feel in having him as my friend for almost forty years, then we do have something very much in common.

I close with just this final thought from Oliver Wendell Holmes:

The sea drowns out humanity and time. It has no sympathy with either.

For it belongs to eternity. And of that it sings its marvelous song forever and ever.

William Crook: Thank you very much. Thank you. That was not on the program.

Bill Moyers: It'll be stricken from the record by the president, no doubt.

William Crook: Since you spoke a personal word, let me just respond with a couplet or two.

What makes a friend? What filmy strands

Are these that turn to iron bands?

Ah, these are things one understands,

but once or twice.

Well, I don't feel so much like Texas and philosophy are oxymorons after all. I've been so proud of your response, your questions. And who could not be grateful to the men and the lady we have here? And I know you want to express your appreciation to them.

It seems as if Amy Freeman Lee's question is leading this morning. As I sat looking down the profiles of our scientists here, it occurred to me that the mantle of the prophet in our time has passed from Isaiah and Jeremiah to our scientists. Someone asked why we didn't believe them. Perhaps it is because we've been taught for so long, especially in our Bible Belt, that they were bad people. Yet the moral word—the definitive word today—the warning word is coming from the scientific community in every sphere of their activity.

And it is time—these prophets have spoken definitively with concern. And it's time we listen to them.

What I've learned from this is just how transient the world is and everything connected with it. In our time we've seen empires rise and fall, and states and isms and ideologies. And I want to close using the president of our scientists last year, who switched from pure science to a little sentiment, and close with a poem, which, to me, is the reassuring North Star from Tennyson.

Our little systems have their day.
They have their day and cease to be.
They are but broken lights of thee, O Lord,
And thou art more than they.
Travel safely.

THE OCEANS: THE ORIGIN,
THE MYSTERY, THE MYTHS*

SCOTT E. STEWART

It was meteorology at its simplest. When this planet was very, very young, with life only a twinkle in Earth's eye, the cooling of the globe forced its shroud of water vapor to condense and fill all available basins. As global temperatures stabilized, permitting water to exist in all three of its states, the cycle of evaporation and precipitation had already begun to mix the inorganic salts of the earth's crust into the largest and deepest of the various water bodies. The resulting oceans provided an ideal medium for the formation of organic molecules, some of which eventually coalesced into animate matter, then living cells.

But is that really the way life began? Perhaps the oceans were seeded with extraterrestrial, well, *bacteria* for lack of a better descriptor. These bacteria found the moist oceanic environment a far more hospitable dwelling place than the backs of the meteorites on which they wildly rode to the planet's surface. Evolution then took care of the rest. Or perhaps chaos and chance had little to do with it. Perhaps a yet undefined force served as the principal cause of a miraculous effect: the nascence of an entity that was able to maintain a homeostatic internal environment apart from the sea around it and, most incredibly, to recreate itself.

Whether we attribute the origin of life to a proper mixing of the primordial soup, the touch of an extraterrestrial hand or the finger of God, the dense liquid womb of the ocean was a necessary precursor to the life that makes oceanic origins meaningful, mystery conceivable and myths possible. Any serious student of biology will quickly notice that all the world's myriad life forms depend on water, forms that either perish or suspend their vital processes to death-like levels when desiccated. No form of reproduction succeeds without sufficient moisture. Tough-shelled terrestrial eggs, for instance, carry their sea inside them in which the embryos develop, suspended. The creatures that hatch therefrom possess integuments that severely restrict the loss of the sea that was transferred into their feathered, furred or scaly bodies. The same is true for those embryos that incubate

*Winner of the Society's \$2,000 President's Award for Outstanding Essay. Scott E. Stewart is a graduate student in the Department of Marine Science at the University of Texas at Austin.

within a parent's internal sea, or, still, develop in a pond, lake, stream, river or ocean. The circumstantial evidence is damning. The origin of the oceans is our origin. The mystery of the oceans is our mystery.

This mystery has given rise to numerous myths about the sea and its influence on the human beings who initially either fear it or expend futile efforts to sweep it back. In either case, experience and curiosity work cheek by jowl to convert fear and obstinacy into respect, yet the myths persist. How else can one explain the "romance" of the sea? Why should human-kind in various circumstances describe the ocean as mother, lover, friend and beast in the same breath? Supportive, seductive, gentle, brutal, at once cold and impersonal yet benevolent and generous—all apply to virtually any body of water whose opposite shore cannot be seen, but best describe oceans. The mystery of the unknown together with a capricious *persona* have called forth from the mind of Man needful explanations for the behavior of the ocean and its inhabitants, seen and unseen, real . . . and imagined.

"A myth is all about wonders," wrote Aristotle in his *Metaphysics*,¹ and just as the wonders of the sea appear innumerable, myths about the sea abound. For Western civilization, the Hebrew scriptures and the ancient religions of Greece and Rome provide key material. The Psalms and the Book of Isaiah mention Leviathan, "the dragon who lives in the sea," a creature created by God and invincible but to Him alone; the penultimate chapter of the Book of Job provides a detailed description of the same creature with "rows of shields" for scales, whose "breath kindles coals," a creature whose "heart is as hard as a stone" and who, when aroused, makes the mighty fear.² Leviathan, the archetype for Melville's white whale,³ becomes an apt metaphor for the ocean and its power. Odysseus found the sea a particularly vicious and sinister environment in *The Odyssey*,⁴ one to survive rather than conquer, and that only by divine aid. Heeding the advice of the goddess Circe, Odysseus saved his ship and crew from the irresistible call of the Sirens only to lose a half dozen of his best men while passing betwixt Scylla and Charybdis.

If anthropologist William Howells is correct, moral values are fundamental to a myth's endurance and make myths repositories of cultural philosophy.⁵ *The Odyssey* teaches us not so much to avoid Scylla and Charybdis, for the only alternative to those two was a certain death, but to face a challenge with stoic strength, subduing fear and shunning hubris. Like Leviathan, the Odyssean sea is "one made without fear" and "king over all the sons of pride."⁶ The more recent myth of the Flying Dutchman describes the penalty for those who commit the deadly sin of pride on the high seas: no escape and a poisonous influence on all who come in contact with the Dutchman's moral failure. Those who succumb to fear, like Joseph

Conrad's Jim,⁷ likewise pay their debt in the end to the sea that broke them. The mythical sea is a proving ground, testing human mettle and reluctantly yielding only the fruits that are hard-won by courage and wisdom, if not experience. In this way, the oceans exemplify the obstacle to be overcome in every rite of passage, an obstacle wrapped in mystery to the uninitiate.

Just as children experience life on a much smaller scale, the child's respect for the sea does not and even cannot go beyond the terror of breakers or toe-pinching crabs in the surf. In like manner, Man to this day is handicapped by a limited vision of the ocean and its true significance. He remains uninitiated in spite of his increasing skill at surviving and subduing Leviathan, for, though Man has largely overcome his fear, his damnable pride remains. The oceans are not merely significant for size alone, nor even for the edible and useful products they harbor. We know this because we have spanned the seas and now strip them, heedless of the consequences, of their wealth. The awe one feels when one first sees an ocean echoes a far deeper element that is often demoted to the inferior concepts of physical dimension and available resources. Since these do no justice to the awe, what does? The ocean as wilderness, a place "in which a person feels stripped of guidance, lost, and perplexed,"⁸ offers a strong clue. It exposes us to what Rachel Carson describes as "an uneasy sense of the communication of some universal truth that lies just beyond our grasp," the pursuit of which brings us to the threshold of "the ultimate mystery of Life itself"⁹ It is this mystery that we rebuff when we refuse to grapple with the true nature of our awe.

Isaac Newton once described himself and his accomplishments as if he were merely a boy picking up and admiring pretty shells and pebbles on the shore of the ocean of knowledge. Thanks to Darwin, Einstein and their successors, we have begun to wade into the shallows, but what have we found there that is qualitatively different from what has washed ashore? I speak of Aristotle's ultimate cause, "that for the sake of which something else is."¹⁰ It is not enough simply to collect and identify what remains unknown, nor even to determine how the unknown works. What is unknown works just as what is known works, whether from the tide pools or the abyss, but the ultimate cause is quite another matter. If Carson speaks truly that the universal truth that can touch us lies beyond our ken, then we are doomed, as doomed as the Flying Dutchman. If we are capable of understanding Life's ultimate mystery, then we still face the Sirens and our own fearful Scylla and Charybdis. To fear those monsters is understandable, but if Man does not risk passage, he will die without ever knowing why he lived.

By the time Circe offered her advice to him, Odysseus, having just returned from a voyage to Hades, had long forsaken pride and gave heed

to something beyond himself.¹¹ Like Odysseus, humankind has foreseen its demise. We must not delude ourselves; there is no safety in our numbers. No one is immune to the Sirens' call but those who cannot hear it or ensure that they do not heed it. The self-discipline that will conduct the human race safely beyond that risk of hedonistic self-destruction to where Scylla and Charybdis await will not then suffice, but will remain necessary. Scylla, despite her many monstrous heads, is to be feared less than Charybdis, the whirlpool of oblivion. Charybdis represents our egalitarian fate should we fail to answer the question of our existence. If we succeed, we still pay Scylla's price, but if we succeed, it will be because we have realized we are not self-sufficient.

I believe we can answer the question. We are capable of understanding the meaning of our existence, and the question is not a logical absurdity. If the question exists, so does the answer. If passage proved possible to Odysseus, then his return home was also possible, though fraught with impending loss and delay, not a given. Odysseus endured, as we must, but first things first. We must begin by reconciling the sea within us with the sea without, for, though greatly separated by time, they are one. If we will coexist with Leviathan, rejecting Ahab's self-destructive obsession to consummate human passion,¹² we will find ourselves safely past the Sirens. Then we will face our true rite of passage, supported by the oceans of our mysterious origin.

ENDNOTES

1. Aristotle, *Metaphysics*, trans. J. H. MacMahon, in *On Man In The Universe*, ed. L. R. Loomis (Walter J. Black, Inc., 1943), p. 9.
2. Psalm 104:26, Isaiah 27:1, Job 41, in *New American Standard Bible* (Cambridge University Press, 1977).
3. Herman Melville, *Moby-Dick; or The White Whale* (first published in 1851).
4. Homer, *The Odyssey*, trans. Samuel Butler, ed. L. R. Loomis (Walter J. Black, Inc., 1944), pp. 147-153.
5. William Howells, *Back of History*, Revised ed. (Doubleday and Company, Inc., 1963), p. 238.
6. Job 41:33-34, *NASB*.
7. Joseph Conrad, *Lord Jim* (first published in 1900).
8. Roderick Nash, *Wilderness and the American Mind*, Revised ed. (Yale University Press, 1976), p. 3.
9. Rachel Carson, *The Edge of the Sea* (Houghton Mifflin Co., 1955), p. 250.
10. Aristotle, p. 12.
11. Homer, pp. 147-148.
12. Melville, *Moby-Dick*.

MEMORIALS

KATHARYN DUFF
1915–1995

Katharyn Duff, Abilene journalist, historian, and political analyst, died Friday, July 14, 1995. Duff, well known in West Texas through her long-running, page-one column in the *Abilene Reporter News*, also collected the story of Abilene into a folksy pair of local history books, *Abilene . . . On Catclaw Creek* in 1969 and a revised version, *Catclaw Country* in 1980. Duff was born in Rusk, Texas, in 1915 and was reared in the Fisher County community of Sylvester. She graduated from Hardin-Simmons University in Abilene and joined the *Abilene Reporter News* staff in the fall of 1943. Katharyn Duff won many state and national awards for her newspaper work, especially in her coverage of water pollution. Her reportage won the national Thomas L. Stokes Award in 1961 for the best writing in the field of conservation.

While confessing to be a lifelong “yellow-dog Democrat,” Duff never pulled her punches, criticizing and praising politicians regardless of their stripe. She was a great supporter of the small-business owner, the individual, the “little guy.” While her interest in politics brought her into contact with the nation’s leaders, her West Texas heritage never let her forget the men and women who worked daily at the ordinary jobs of life.

Katharyn was as salty as the oilfield pollution she reported. Columnist Bill Whitaker recalled the temerity with which she was regarded by newcomers at the paper. “Back in the 1970s,” he recalled, “Katharyn had a habit of writing her page one column early each morning on one of the word processors up at the front of the newsroom. One morning, while Katharyn was off refilling her coffee cup, a young reporter failed to notice that Katharyn’s pile of cigarette ashes were, indeed, her particular claim to that computer. He sat down and began working. Upon returning to the computer and finding it occupied, Katharyn gave the young reporter—in fact, he was the religion editor of our paper then—such an inspired tongue-lashing that the pasty-white religion editor quietly turned in whatever he was working on, walked out the door and was never seen again . . . he had gotten his things and moved to Lubbock.”

In her role of political pundit for the newspaper, she developed a close friendship with Lyndon and Lady Bird Johnson. Her first interview with Johnson came during his campaign for the United States Senate. She had

unsuccessfully followed the candidate all day trying to get a few words when finally she cornered him and asked for a story. Johnson said he would be happy to oblige but he had to use the bathroom. Her first interview with the future president was through a bathroom door. Liz Carpenter, former press secretary for Lady Bird Johnson, characterized Katharyn as a person of honesty, with the heart and character typical of West Texas. "When I was in the White House and wanted to know something about West Texas, we'd call Katharyn . . . she could always give you the best advice."

All her life, Katharyn Duff was a champion of West Texas. Not a defender, because West Texas needs no defense. As her fellow reporter, Whitaker, phrased it, "If you had some faith in this land, displayed some understanding of its people, it didn't matter to her that you weren't born in Texas, though that sure helped. But if you came here to put in your time and then leave, and you viewed this land with contempt, she was likely to view you with contempt."

I was privileged to know Katharyn Duff as a personal friend and fellow Abilenian. I saw and admired her efforts to build a better community and a better nation. She never married but cared for her sister and family through their lives and illnesses, just as she cared for the rest of us in her sometimes gruff but always heartfelt way. She was an intellectual, a populist, and a real person in every sense of the word. She moved easily among common folk and understood their needs and desires as one of them, and among the rich and powerful, and dispassionately observed their strengths and weaknesses, their contributions and failures. She was as weathered as the land that romanced her and, like the old mesquites she loved, she had her roots down to the water and stood strong against the storms of our times.

W.P.W.

RUTH HARTGRAVES
1901-1995

Ruth Hartgraves, a Houston obstetrician and gynecologist, one of Texas's most eminent medical pioneers in her field passed away on October 17, 1995, at the age of ninety-three.

Ruth Hartgraves was born on October 24, 1901, in Norse, a small community near Waco. After her family moved to Menard, she attended public schools there but graduated from Brownwood High School in 1919 in order to have adequate preparation to enter the University of Texas, which she did in 1919. She entered the University of Texas Medical Branch at Galveston in 1922, along with her sister. Due to very difficult economic years for her family, she was forced to stop after only one year and she briefly returned to the University of Texas and earned her B.A. degree in 1925, then taught science in Matador, Texas, for three years. She reentered UTMB at Galveston in 1928 and was graduated as an M.D. in 1932.

Typical of her courage and determination, immediately upon graduation she was accepted for an internship program in Boston at the New England Hospital for Women. She told of starting on a three-day train ride in a chair car from Menard, Texas, and heading for Boston with five dollars in her purse, a shoe box full of food that had to last for three days, and all of her possessions in a small suitcase, thus starting a life of medical practice for one who would become one of the most respected, admired, and loved doctors in our state.

After finishing her internship in Boston in 1933, she accepted a residency in obstetrics and gynecology in New York City at the New York Infirmary for Women and Children, and was there through 1934. She then moved to Houston and opened her office in obstetrics and gynecology in 1935. Shortly after having been named to the faculty of Baylor College of Medicine in 1943, she immediately became the Mother in Residence to almost all of the women then attending Baylor, even purchasing a house to be used as a residence for these young women. She was a faculty member of Baylor for almost thirty years. Although she kept an active practice in gynecology until June of 1985, she stopped delivering babies around 1970, by which time she had delivered approximately 4,000 infants.

During her medical career, Dr. Hartgraves held appointments at Methodist, Hermann, Memorial, St. Luke's, and Jefferson Davis Hospitals, and in 1976 she became Professor Emeritus at the University of Texas Health Science Center in Houston. She organized the Houston Branch of the American Medical Women's Association in 1956 and served as its first President, and was National President of the American Medical Women's Association in 1963. Dr. Hartgraves was the recipient of the 1992 Distinguished Professional Women's Award which is presented by the Committee on the Status of Women, which was given in recognition of her outstanding achievements and for the significant contributions she made to her professional discipline and for her pioneering spirit to mentor women and to provide a positive role model.

In 1980 Dr. Hartgraves was the recipient of the Ashbel Smith Distin-

guished Alumnus Award granted by the UTMB School of Medicine Alumni to graduates who had made significant contributions to the profession and to mankind. In 1985 she was awarded the Distinguished Alumnus Award from the University of Texas at Austin. In 1975 she was awarded the highest honor given by the American Medical Women's Association, the Elizabeth Blackwell Award, presented annually to a single individual making an outstanding contribution to the cause of women in medicine, the first Texas physician to be so recognized. She was the recipient of an honorary Doctor of Science Degree from Southwestern University at Georgetown, Texas, in 1976. This was the first Doctor of Science Degree ever awarded by Southwestern since its founding in 1840. She served on President Kennedy's Commission on the Status of Women; received the Outstanding Woman Award from the Houston Chapter of the American Business and Professional Women's Association. In addition to all of these honors, perhaps her most important achievement was the giving of herself so freely in being an advisor and counselor to younger women doctors who needed her counsel as they faced the problems of competing in a male-dominated profession. She frequently provided financial support for those who were just getting started in their practices.

Ruth Hartgraves was a very important member of Houston's civic and cultural life. She was an active supporter as well as one who enjoyed very much the Houston Grand Opera, the Houston Symphony, the Houston Ballet, the Houston Museum of Fine Arts, and the Friends of Bayou Bend. She was a very involved and loyal member of St. Luke's Methodist Church in Houston. She was reared as a Methodist and stayed very involved in the life of that church from the late 1940s until her death. She particularly enjoyed the music of the church and was almost always in attendance at any musical program.

Ruth Hartgraves was cherished by her patients because she was a superb listener. She gave her patients all the time that was needed, not only to take care of them medically, but to listen to their fears and anxieties. She was totally respected within the medical community of Houston, and most especially the staffs of Baylor College of Medicine and the Methodist Hospital, for being an outstanding physician, whose judgment was excellent and whose work habits knew no limits, who enjoyed not only the affection but the total confidence of her patients, and who represented as fine a role model as the medical profession could ever have.

J.S.B.

OVETA CULP HOBBY
1905–1995

Oveta Culp Hobby, one of the outstanding Americans of the twentieth century and a long-time member of the Philosophical Society of Texas, died August 16, 1995, at her home in Houston. She was ninety.

In World War II, Mrs. Hobby was the first woman in United States history commissioned to organize and command an army of 200,000 women. A decade later, appointed to his cabinet by President Eisenhower, she organized and headed the vast new Department of Health, Education, and Welfare. These were two highlights of a career that held many lasting benefits for her state and her country.

Born in Killeen, Texas, January 19, 1905, Oveta Culp was an avid reader from early childhood. At ten, she read the *Congressional Record* in her lawyer father's office. At thirteen she had read the Bible three times. When her father was elected to the state legislature, he took the fourteen-year-old Oveta with him to Austin where she attended every session. At age twenty, Oveta Culp became parliamentarian of the Texas House of Representatives, though she was still too young to vote. Still in her twenties, she wrote a book on parliamentary procedure that became a high school textbook. As clerk of the State Banking Commission, she codified the state's banking laws.

At the time of her marriage in 1931, young Oveta Culp was almost as famous within Texas as her distinguished husband, former Governor William Pettus Hobby. Together they formed a team of unusual closeness in all they undertook—publishing the *Houston Post*, managing the KPRC radio and television station, taking part in state and national politics, and always seeking the betterment of the human condition for all Americans. Oveta Hobby was an early member of the NAACP and of the League of Women Voters, and the Hobby team was steadfast in support of civil rights for all Americans. At the start, Will Hobby was the publisher, while Oveta moved through Post departments learning and working. Increasingly, it was she who went to Washington to deal with the FCC on matters of television and radio.

Oveta Culp Hobby leaped to international fame with her appointment as first director of the Women's Army Corps. At thirty-six, and without precedents to go by, she developed and deployed the corps. As pioneers, the WACS had to bear the slings and slurs that later women's services were spared. But they proved their worth. Expected to handle 59 soldierly tasks, Wacs were filling 239 of them by war's end. In 1944, generals around the world were calling for Wacs—600,000 of them. This was three times the total authorized strength of the corps. Colonel Hobby was awarded the

Distinguished Service Medal—the first woman to receive it.

In 1953, aware of her organizational ability from the war days, President Eisenhower asked Mrs. Hobby to bring together a vast assortment of bureaus and agencies into a new Department of Health, Education, and Welfare. She called upon some of the nation's finest minds to analyze and plan. She sent bill after bill to Congress, and gained sweeping improvements and expansions that meant the difference between grim poverty and a productive life for millions of Americans.

Time Magazine reported on May 4, 1953, Oveta Hobby's "new job brings her into direct contact with more U.S. citizens than anyone else in Government." The *American Magazine* of May, 1953, said, ". . . Mrs. Hobby has assumed the biggest job any woman ever held in this country . . . her activities touch the personal lives of all of us. . . ." She is, among other things, "the biggest insurance executive and pension payer on earth; the No. 1 angel of the sick, aged and handicapped; the nation's top boss of medical research; and our greatest guardian of poor children. She is also a super-protector of food and drugs." Though issued amid controversy, the Salk polio-vaccine program was a major accomplishment of her term.

Because of her husband's grave illness, Mrs. Hobby resigned after thirty-one months. President Eisenhower called it "a sad day for the administration." Hearing the news, Secretary of Treasury George Humphrey cried "What? The best man on the cabinet?" One news service reported "Not since Harry S. Truman . . . has anyone left office in Washington with such fanfare as was accorded Mrs. Hobby at the White House."

With improving health, Governor Hobby became chairman of the *Post* board, while Mrs. Hobby took over as president and editor. The team was still in place until his death. After the Hobby family sold the *Houston Post* in 1984, Mrs. Hobby became chairman of H&C Communications which owned several television and radio stations.

Throughout her corporate career, Oveta Hobby served on many public boards, including the Corporation for Public Broadcasting, Rice University, the Houston Symphony Society, and Houston's Museum of Fine Arts. In 1948 she was a member of the U.S. delegation to the U.N. Conference on Freedom of Information and the Press in Geneva. In 1949, as president of the Southern Newspaper Publishers Association, she urged the members to prepare for the computer era. The *Houston Post* was one of the first papers in the world to be fully computerized. And always, the Hobby team supported civil rights. When the Supreme Court was due to hand down the Brown decision that desegregated the nation's public schools, the *Post* was ready: page one carried statements by every major religious leader in support of the decision.

Though she attended Mary Hardin Baylor College and audited classes at the South Texas Law School, Oveta Hobby was largely self-educated—largely and richly educated. Her wide-range of reading continued all her life. Newly turned ninety, she was as avidly interested in the world of arts, science, literature, and government as she had been at twenty, and welcomed new murder mysteries by her favorite authors. Museum curators comment on the excellence of her eye in choosing art. And in her concern over her friends and family, she was often teased about practicing medicine without a license.

With all, Oveta Culp Hobby was a person of infinite charm, beauty, and wit. Her sincere interest in the lives and welfare of those around her were irresistible. Of the highest ethics, personally and professionally, she had the humor to enchant. And in service to her country, she achieved greatness.

She is survived by her son, William Pettus Hobby Jr., for twelve years lieutenant governor of Texas, and her daughter, Jessica Hobby Catto, nationally known for her work in environmental development, by eight grandchildren and 12 great-grandchildren.

M.J.

DANIEL EDMOND KILGORE
1921–1995

Daniel Edmond Kilgore, a member of the Philosophical Society of Texas since 1976 and a former president of the Texas State Historical Association, died December 23, 1995, at Corpus Christi, where he had lived for more than forty years.

Although Dan was a CPA by profession, his greatest accomplishments were in the field of Texas history, and it was in recognition of these contributions that he was elected to the Philosophical Society. He was, in particular, an authority on the history of South Texas.

He was also an enthusiastic collector of Texana who accumulated two major libraries pertaining to South Texas. He gave the first, some 10,000 volumes and documents valued at \$385,000, to Texas A&M University-Corpus Christi in 1984. But his addiction to collecting Texana, which he called “an incurable malady,” did not disappear with his library, and on his death he left another substantial collection to TAMU-Corpus Christi.

Kilgore led a busy professional and civic life. Therefore, his work in history had to be done in "off hours" and without the help of a secretary, researcher, or graduate student—conveniences of great usefulness to many of his brother historians. His works include *How Did Davy Die* (1978), and contributions to *A Ranger Legacy: 150 Years of Service to Texas; Nueces County, Texas 1750-1800; Francisco Bexerra, as Told to John S. Ford in 1875; A Mexican Sergeant's Recollections of the Alamo and San Jacinto*; and scores of monographs, newspaper and magazine articles, and papers presented before various historical societies.

In 1976 his colleagues elected him president of the Texas State Historical Association. He was, of course, a members of almost all the regional historical societies in South Texas, and a prolific contributor to their publications and to newspapers in South Texas.

Robert H. Thonhoff of Karnes City, a friend and past president of the Texas State Historical Association, said "Dan Kilgore was a trail blazer in Texas history. In 1991 he was honored for his efforts in history by being elected a Fellow of the Texas State Historical Association. He will undoubtedly be remembered and appreciated by historians" for years to come. Bruce C. Cheeseman, archivist and historian for the King Ranch, wrote that "Kilgore's modest nature led him to avoid praise and thanks," but that he will be remembered "for his contribution to the ongoing challenge of documenting the history of South Texas and Corpus Christi." Kilgore, Cheeseman added, "helped provide a workable record of the past, asked good questions, and gave interesting, significant and true answers."

Kilgore was born in Dallas, and got his bachelor of business administration from the University of Texas at Austin in 1943. He belonged to the American Institute of Certified Public Accountants and had been secretary of the Texas Society of Public Accountants and president of the Corpus Christi chapter.

Kilgore was born with a club foot and when he was three years old he contracted polio, which left his legs almost useless. He worked his way through life—painfully, no doubt—with crutches and braces, but never mentioned his handicap, either to explain or complain.

Kilgore is survived by his wife, Carol Isensee Kilgore of Corpus Christi; a daughter, Nancy J. Kilgore of San Antonio; and two sons, Daniel Kilgore Jr. of Waco and Christopher H. Kilgore of Houston. A brother, William Jackson (Jack) Kilgore, also a member of the Philosophical Society, preceded him in death in 1993.

E.H.H.

ABNER VERNON MCCALL
1915–1995

Valedictorian of the Masonic Home High School in 1933, Baylor Law School top graduate in 1938, highest score ever made on the Texas Bar Examination to that time (1938), practitioner and Baylor assistant professor of law 1938–42, LL.M. University of Michigan Law School 1943, FBI agent 1943–45, practitioner and Baylor professor of law 1945–48, Baylor law dean and professor 1948–59, Associate Justice, Texas Supreme Court, 1956, Executive Vice President of Baylor University 1959–61, President of Baylor University 1961–81, Chancellor of Baylor University 1981–85, President Emeritus of Baylor University 1985–95, Abner McCall was truly *sui generis*.

After the loss of his father in the influenza epidemic of 1918–19, and his mother's loss of health in the four years thereafter, Abner McCall and his sister and brothers were invited by Abner's late father's Masonic brethren to come and take up residence in the Masonic Home in Fort Worth. From that time until his death, Abner was a staunch supporter of Masonic benevolences and an illustrious 33° member of the brotherhood that had so greatly influenced his life.

During his Baylor days as an undergraduate and law student Abner McCall became a member of the J. M. Dawson household. Dr. J. M. Dawson was Abner's pastor at First Baptist Church of Waco, and Dr. and Mrs. Dawson treated him like one of their own children. Abner forged his closest lifetime friendship with the Dawson's son, Matt, an esteemed Baylor law graduate and trial lawyer *par excellence*. Abner McCall and Matt Dawson graduated together from the Baylor Law School, practiced law together in Longview, Corsicana, and Waco for many years, went on family vacations together and were like brothers, personally and professionally. Their friendship spanned the sixty-two years from 1933 to 1995.

Married in 1940 to Frances Bortle, Abner McCall was a devoted husband and father of daughters Anne McCall Chroman, Bette McCall Martin, Kathleen McCall Sigtenhorst, and son Richard (Dick) McCall, Esq., with grandchildren he loved dearly. His daughter Bette described her father in this way in 1981 as he was retiring from the Baylor presidency “. . . somehow, when we reached those skeptical disdainful teen-age years, I do not remember that any of us ever doubted his knowledge, his wisdom, or his judgment—he was simply right too often. Even now, I would feel a little uncomfortable if I discovered that my opinion on a matter differed from his—I would have the nagging suspicion that it was I who was wrong!” And also, “Because of his humility and complete unpretentiousness, we

became only subtly aware of one aspect of our father's character, and that was his firm conviction that we are indeed our brothers' keepers. He gave regularly and unstintingly to his church and to other institutions and agencies, and he and Mother personally helped support needy individuals as well as causes. His Christianity expressed itself beautifully in his love for his neighbor, and he had little patience with those who claimed to love God and did not seem to love their fellow men."

Frances Bortle McCall died suddenly at age fifty in June 1969, and McCall experienced the darkest moment in his life. In the months that followed, he was sustained by his deep faith and personal resilience, regaining his balance through his daily work and witness.

On December 25, 1970, McCall married Mary Wilson Russell, who had lost her husband, Dr. Lloyd Russell, a Baylor faculty member, in 1968. Mary attended Baylor in the late 1930s and had known Abner and the members of the "Baylor family" since those days. Mary and Abner McCall and their two families spent twenty-five significant and meaningful years together.

A dedicated churchman, Abner McCall taught what was to become "The McCall Class" at First Baptist Church of Waco from 1948 to 1995. Judge McCall was also an avid political partisan and pundit from his Baylor student days until his death, and he knew and was known by virtually all the major politicians at the local, state, and national levels.

Abner McCall "travelled light" all of his life, generally unencumbered by the myriad of trappings and burdens which weigh down the average person. He freed himself to act forcefully and with ever-increasing credibility, and became a singularly respected leader within the state of Texas and throughout the nation. His devotion to Baylor, to higher education, to all worthy causes and to our Lord has set him apart and gives him an abiding place in our hearts. As Shakespeare says in *Julius Caesar*,

He only, in a general honest thought,
And common good to all, made one of them.
His life was gentle; and the elements
So Mix'd in him that Nature might stand up
And say to all the world, 'This was a man!'

H.H.R

OFFICERS OF THE SOCIETY

For the Year 1996

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PAST PRESIDENTS

*Mirabeau Buonaparte Lamar	1837-59
*Ira Kendrick Stephens	1936
*Charles Shirley Potts	1937
*Edgar Odell Lovett	1938
*George Bannerman Dealey	1939
*George Waverley Briggs	1940
*William James	1941
*George Alfred Hill Jr.	1942
*Edward Henry Cary	1943
*Edward Randall	1944
*Umphrey Lee	1944
*Eugene Perry Locke	1945
*Louis Herman Hubbard	1946
*Pat Ireland Nixon	1947
*Ima Hogg	1948
*Albert Perley Brogan	1949
*William Lockhart Clayton	1950
*A. Frank Smith	1951
*Ernest Lynn Kurth	1952
*Dudley Kezer Woodward Jr.	1953
*Burke Baker	1954
*Jesse Andrews	1955
*James Pinckney Hart	1956
*Robert Gerald Storey	1957
*Lewis Randolph Bryan Jr.	1958
*W. St. John Garwood	1959
George Crews McGhee	1960
*Harry Hunt Ransom	1961
*Eugene Benjamin Germany	1962
*Rupert Norval Richardson	1963
*Mrs. George Alfred Hill Jr.	1964
*Edward Randall Jr.	1965
*McGruder Ellis Sadler	1966
*William Alexander Kirkland	1967
*Richard Tudor Fleming	1968
*Herbert Pickens Gambrell	1969
*Harris Leon Kempner	1970
*Carey Croneis	1971
*Willis McDonald Tate	1972

*Dillon Anderson	1973
*Logan Wilson	1974
*Edward Clark	1975
Thomas Hart Law	1976
*Truman G. Blocker Jr.	1977
Frank E. Vandiver	1978
*Price Daniel	1979
Durwood Fleming	1980
Charles A. LeMaistre	1981
*Abner V. McCall	1982
*Leon Jaworski	1983
Wayne H. Holtzman	1983
Jenkins Garrett	1984
Joe R. Greenhill	1985
William Pettus Hobby	1986
Elsbeth Rostow	1987
John Clifton Caldwell	1988
J. Chrys Dougherty	1989
*Frank McReynolds Wozencraft	1990
William C. Levin	1991
William D. Seybold	1992
Robert Krueger	1993
Steven Weinberg	1994
William H. Crook	1995
Charles C. Sprague	1996

*Deceased

MEETINGS OF THE PHILOSOPHICAL SOCIETY OF TEXAS

December 5, 1837 - Founded at Houston	1964 - Austin
January 29, 1839 - Austin	1965 - Salado
January 18, 1936 - Chartered	1966 - Salado
December 5, 1936 - Reorganizational meeting - Dallas	1967 - Arlington
	1968 - San Antonio
January 29, 1937 - Meeting and inaugural banquet - Dallas	1969 - Salado
	1970 - Salado
December 4, 1937 - Liendo and Houston	1971 - Nacogdoches
1938 - Dallas	1972 - Dallas
1939 - Dallas	1973 - Austin (Lakeway Inn)
1940 - San Antonio	1974 - Austin
1941 - Austin	1975 - Fort Worth
1942 - Dallas	1976 - San Antonio
1943 - Dallas	1977 - Galveston
1944 - Dallas	1978 - Houston
1945 - Dallas	1979 - Austin
1946 - Dallas	1980 - San Antonio
1947 - San Antonio	1981 - Dallas
1948 - Houston	1982 - Galveston
1949 - Austin	1983 - Fort Worth
1950 - Houston	1984 - Houston
1951 - Lufkin	1985 - College Station
1952 - College Station	1986 - Austin
1953 - Dallas	1987 - Kerrville
1954 - Austin	1988 - Dallas
1955 - Nacogdoches	1989 - San Antonio
1956 - Austin	1990 - Houston
1957 - Dallas	1991 - Galveston
1958 - Austin	1992 - Dallas
1959 - San Antonio	1993 - Laredo
1960 - Fort Clark	1994 - Austin
1961 - Salado	1995 - Corpus Christi
1962 - Salado	1996 - Dallas
1963 - Nacogdoches	

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(AS OF AUGUST, 1996)

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