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COASTAL WETLAND AND GLOBAL CHANGE



USGS

and the engineering world

National Wetlands Research Center



U.S. Department of the Interior
U.S. Geological Survey

Photos by: NOAA, USGS, and Roy Darville, ETBU

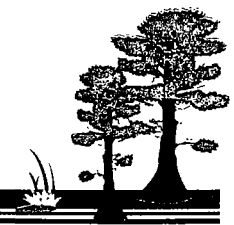
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Coastal Wetlands and Global Change: Overview



The potential impacts of climate change are of great practical concern to those interested in coastal wetland resources. Among the areas of greatest risk in the United States are low-lying coastal habitats with easily eroded substrates which occur along the northern Gulf of Mexico and southeast Atlantic coasts. The Intergovernmental Panel on Climate Change (IPCC) and the World Meteorological Organization (WMO) have identified coastal wetlands as ecosystems most vulnerable to direct, large-scale impacts of climate change, primarily because of their sensitivity to increases in sea-level rise.

Global sea level has risen between 10 and 25 cm over the past 100 years. The IPCC (1995) expects average sea level will continue to increase as a result of thermal expansion and melting of glaciers and ice sheets. Models using the IPCC's current "best estimate" values of climate sensitivity and ice melt suggest an increase in sea level of about 50 cm from the present to 2100. Continued rise in sea level will increase the depth of coastal waters and will cause inland and upstream salinity intrusion, both of which will affect fresh and brackish-water wetlands. While there is uncertainty regarding the influence of global warming on the frequency and intensity of storm events, sea-level rise alone has the potential for increasing the severity of storm surge, particularly in areas where coastal habitats and barrier shorelines are rapidly deteriorating. These direct consequences of global change increase the vulnerability of coastal wetlands (including mangroves and salt marshes) which are already heavily impacted by human activities.

Continued loss of coastal wetlands has tremendous economic and biological consequences. These areas provide essential habitat for many endangered and threatened species as well as many commercially important and recreational fisheries. Coastal areas of Louisiana alone provide the natural resource base for a \$1-billion-per-year fish and shellfish industry.

Threatened Habitats

Coastal wetlands will be affected by large-scale climatic shifts. For example, rates of subsidence (the sinking of land below sea level) and sea-level rise (or "eustasy," caused by thermal expansion of water and melting of polar ice caps and glaciers) are not being balanced by accretion (sediment accumulation) in many gulf coast wetlands, resulting in increased flooding, saltwater intrusion into freshwater wetlands, and erosion of the coastline (Fig. 1). Although many coastal wetlands have maintained their relative elevation in response to gradual increases of 1-2 mm/yr in sea-level rise over the last several hundred

years, these rates are projected to increase two- to fourfold within the next century.

Global change models predict a 1° to 3.5° C increase in global mean temperature by 2100 but knowledge is insufficient to reliably model changes in regional precipitation patterns (IPCC, 1995). Variations in patterns of precipitation and temperature can affect the growth of individual trees, tree species population dynamics, ecosystem structure, and the geographic distribution of low-lying forests and forest communities.

Underlying the predicted climatic changes is an overall increase in carbon dioxide concentrations in the



Fig. 1. "Ghost swamps" result when saltwater floods baldcypress swamps.

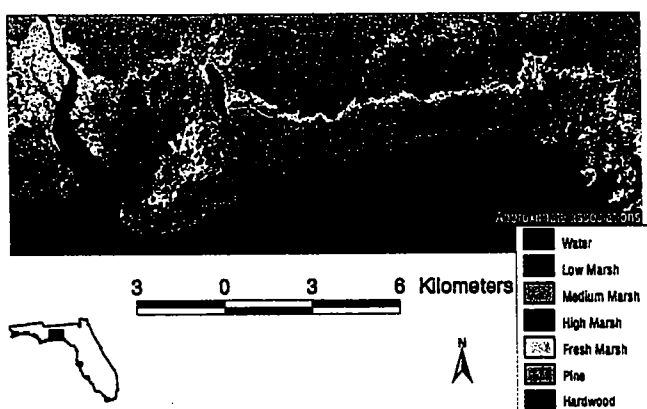
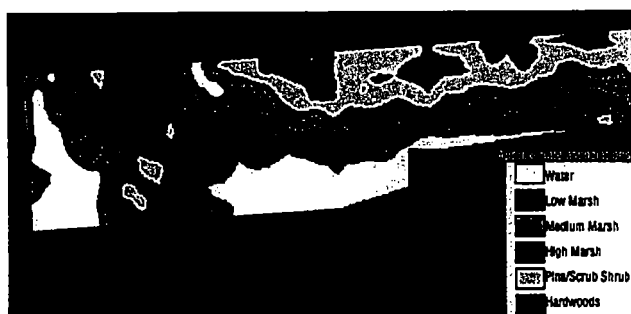


Fig. 2. Vegetation indexes of biomass within marsh and forested wetlands generated from (top) passive microwave data and (bottom) Landsat Thematic Mapper data.

point measurements of inundation and surface topography, the all-weather, day-and-night instrument could allow dynamic monitoring of flood status and the generation of flood-depth surfaces.

Surface Micro Topography

A topographic surface model of a

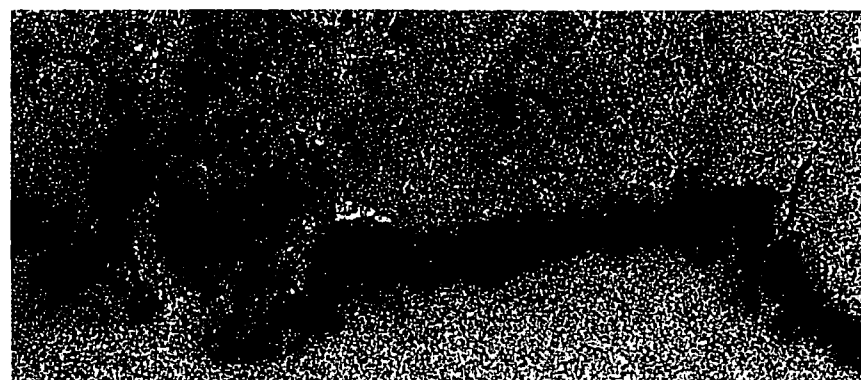
low-lying coastal marsh was created by using three flood extent vectors digitized from satellite radar images and two elevation contours from USGS topographic quadrangles. Excluding abrupt boundaries and topographic highs and lows outside the range of available contours, standard deviation of differences

between measured (747 points) and modeled elevations averaged about 14 cm, but most often averaged about 8 cm. This topographic accuracy represents a five- to nine-factor improvement over the 150-cm topographic resolution currently available for this area.

Soil Moisture and Depth

The depth to the groundwater table and soil moisture content were mapped in a coastal marsh and forest system by measuring energy emitted in the microwave wavelength region. While these results are preliminary, the spatial pattern of the hydrology parameters is consistent with knowledge of the coastal wetland system. If proven to be a reliable estimator of soil moisture and groundwater depth, this technique could allow us to understand how these factors are linked to maintaining a functional wetland.

With remote sensing, information can be collected dynamically on the status of wetland characteristics, offering us the ability to rapidly and repetitively assess changes over large areas. By providing rapid, cost effective, updated data, remote sensing techniques can provide essential information to manage coastal wetlands subjected to alteration by either natural or human-induced influences.



ERS-1 September 13, 1993 (flooded)
Red line indicates the extent of the flood
Green line indicates the extent of the marsh

Fig. 3. Satellite radar images of coastal flooding of a Florida black needlerush marsh.



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Using Remote Sensing to Monitor Global Change



To properly respond to natural and human-induced stresses to wetlands, resource managers must consider their functions and values. Remote sensing is an important tool for monitoring wetland responses to changes in the hydrologic regime and water quality caused by global climate change and sea-level rise.

Extensive marshes, swamps, and mangrove forests fringe most of the U.S. coastline. Besides being an important source of nutrients, coastal wetlands are nurseries for fish and shrimp and habitat for many birds and fur-bearing animals. They are also vital to coastal recreation, maintain water quality, and serve as a buffer against shore erosion.

In the United States, widespread wetland loss has resulted from the filling of marshlands, construction of canals and waterways, and diversion of river sediments offshore. Soil conservation practices and flood-control structures such as dams and levees are preventing sediments from reaching wetlands. Further compounding these human-induced stresses, the eustatic sea-level rise has serious implications for coastal wetlands. Predominantly, the sea level is rising globally from 1 mm to 2 mm yearly; however, increasing rates are predicted to cause about a 50-cm rise in sea level by the year 2100. These problems are especially pertinent to coastal wetlands where the rate of elevation rise may only be about 10 cm for each kilometer traversed inland. If the "greenhouse effect" is confirmed as part of the global climate change scenario, even these levels will be outpaced.

Coastal hydrology is dominated by surface topography, surface drainage, soil character, and local tidal dynamics. With an increasing rate of sea-level rise, tidal dynamics will dominate the hydrology changes within low-lying coastal wetlands. Impacts to these wetlands will include changes

in soil salinity levels, flooding duration and frequency, and water quality. Forecasts of how these changes will affect the present and future wetland species zonation are needed. To make these forecasts, it is necessary to first identify the relationship between wetland type and hydrology. Remote sensing studies conducted by USGS scientists focused on integrating groundbased and satellite measurements to develop tools for measuring and monitoring factors critical to determining these linkages (Fig. 1). They also developed techniques for generating coastal topography to simulate future wetland changes based on uncovered linkages and sea-level rise scenarios.

Wetland Types

A progressive classification of a marsh and forest system combining



Fig. 1. Researchers monitoring salinity and water depth at St. Marks National Wildlife Refuge for comparison with satellite data.

data from Landsat Thematic Mapper (TM), color infrared photography, and ERS-1 satellite radar was developed that improved classification accuracy and resulted in a detailed identification of differences within a nearly monotypic black needlerush marsh in Florida. These types of improvements in classifying coastal land covers are necessary before an accurate portrayal of the link between vegetation characteristics and hydrology can be made.

Vegetation Biomass

Vegetation indexes related to biomass measures were generated from passive microwave data and Landsat TM data. The optical TM vegetation index based on red and near-infrared wavelengths is primarily linked to changes in green biomass. The microwave vegetation index based on measuring energy emitted at 6-cm and 21-cm microwave wavelengths is primarily responsive to the vegetation water content. The images are noticeably similar (Fig. 2). If the microwave instrument proves to be an adequate estimator of biomass in these wetlands, a monitoring program could be developed around this all-weather, day-and-night sensor.

Monitoring Flooding

Satellite radar was used to map tidal flooding, a critical control of coastal vegetation distribution. Radar images taken during a time of near-continuous recordings of ground based hydrology measurements directly linked marsh flooding to lowered radar returns (Fig. 3). Combined with

Hurricane Simulation

A hurricane model, HURASIM, and a mangrove forest model, MANGRO, were combined in a spatially distributed landscape application to review the impact of hurricanes over the last century on forest structure of mangrove communities across south Florida. The model uses historical tracking and meteorological data of dated North Atlantic tropical storms from 1886 to 1990 (Fig. 3). Data input for the model includes tracking information of storm position, latitude and longitude, and maximum sustained wind speed every 6 hours or less. HURASIM model output from Hurricane Andrew was correlated with field data to construct data tables of damage probabilities by site and species and to determine critical windspeeds and vectors of tree mortality and injury.

Mangrove Simulation

MANGRO is a spatially explicit stand simulation model constructed for neotropical mangrove forests of black mangrove, white mangrove, and red mangrove. This individual-based model comprises a species-specific set of biological functions predicting the growth, establishment, and death of individual trees. MANGRO predicts

the tree and gap replacement process of natural forest succession as influenced by stand structure and environmental conditions. For our study, tree mortality was modeled as a random process of age, suppression, and hurricane impact derived from damage probability curves developed from observed data of Hurricane Andrew (1992) effects. If in any given year of the simulation a predicted hurricane windforce exceeded 30 square meters per second, a probability was derived based on windspeed from which a percentage of the standing crop or trees were randomly removed from the forest simulation.

Model Application

Four treatment effects were implemented including a no-hurricane simulation contrasted with a low, moderate, and high mortality effect that increased with corresponding increases in windspeed. A historical simulation for 1886 through 1989 was achieved by passing hurricane and site-specific information from the HURASIM model to the associated MANGRO simulation for common cells. A cumulative assessment of hurricane impact was achieved by averaging stand attributes and size for the entire simulated landscape and time interval from 1890 to 1989. Simulations of hurricane tracks and history for south Florida showed that storm frequency and intensity varied across the landscape. Hurricane frequencies by quadrangle for the period of record showed that the number of storms with winds exceeding 30 square meters per second were more numerous on the Atlantic side than the gulf side of southern Florida. The southwest coast of Florida has endured stronger storms on record than the gulf and Atlantic coasts to the north. The combined layering of hurricane impact showed that there are portions of the south Florida landscape that have received more frequent and more intense storm activity than other portions.

Conclusions

Historical simulations of actual hurricane tracks and conditions seem to account for the structural composition of modern day mangrove forests across south Florida. The occurrence of major storms every 30 years in this century may be the most important factor controlling mangrove ecosystem dynamics in south Florida. Should storms become more intense over the next century, they may further alter the structure and composition of this mangrove landscape. Model results of global change scenarios (high damage probability) indicate that future mangrove forests may be diminished in both stature and extent.

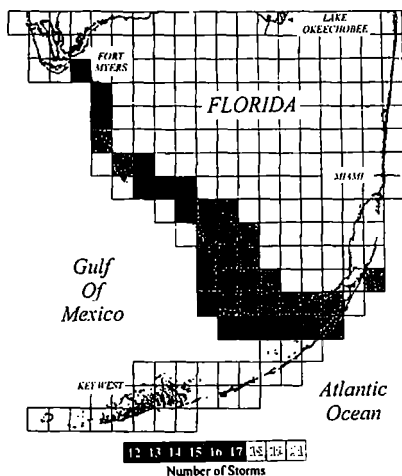


Fig. 3. Frequency of hurricane strikes of category 2 or greater by quadrangle across south Florida for 1886-1989, estimated by the HURASIM model for mangrove habitat.

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Modeling Hurricane Effects on Mangrove Ecosystems



Mangrove ecosystems are at their most northern limit along the coastline of Florida and in isolated areas of the gulf coast in Louisiana and Texas. Mangroves are marine-based forests that have adapted to colonize and persist in salty intertidal waters. Three species of mangrove trees are common to the United States, black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), and red mangrove (*Rhizophora mangle*). Mangroves are highly productive ecosystems and provide valuable habitat for fisheries and shorebirds. They are susceptible to lightning and hurricane disturbance, both of which occur frequently in south Florida. Climate change studies predict that, while these storms may not become more frequent, they may become more intense with warming sea temperatures. Sea-level rise alone has the potential for increasing the severity of storm surge, particularly in areas where coastal habitats and barrier shorelines are rapidly deteriorating. Given this possibility, U.S. Geological Survey researchers modeled the impact of hurricanes on south Florida mangrove communities.

Field and experimental studies were conducted to improve our understanding of species tolerance and community zonation and to aid modeling trials of impacts on mangrove ecosystems. Permanent plots and greenhouse experiments were established to determine growth habits and ecology of mangrove species following disturbance from Hurricane Andrew (Fig. 1). Remote videography was taken at low altitude by helicopter over mangrove forests along the

southwestern coast of Florida to derive a coast-wide assessment of damage extent and pattern. Coastal and inland transects were flown within the mangrove forest boundary over Ten Thousand Island National Wildlife Refuge and Everglades National Park. Video frame analysis assessed the degree of damage, windfall orientation, and canopy height of the forest below (Fig. 2). Aerial videography proved to be an efficient and timely means to document large-scale

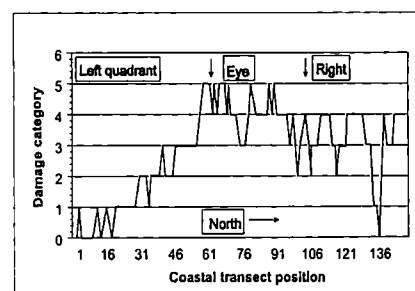


Fig. 2. Mangrove forest damage assessment of coastal transects based on visual interpretation of canopy damage across the hurricane-affected zone.



Fig. 1. Mangrove forest struck by Hurricane Andrew, 1992.

hurricane damage and may also help to monitor ecosystem recovery in the coming years.

Measurements of light penetration through mangrove canopies differentially impacted by hurricane winds of estimated force offer a means to calibrate wind damage probabilities on mangrove forests. Mangrove species and forests are susceptible to catastrophic disturbance by hurricanes such as Andrew that cause significant changes in forest structure and function. These functional relationships of hurricane impacts on mangrove species and systems have been incorporated into a landscape simulation model of south Florida mangroves.

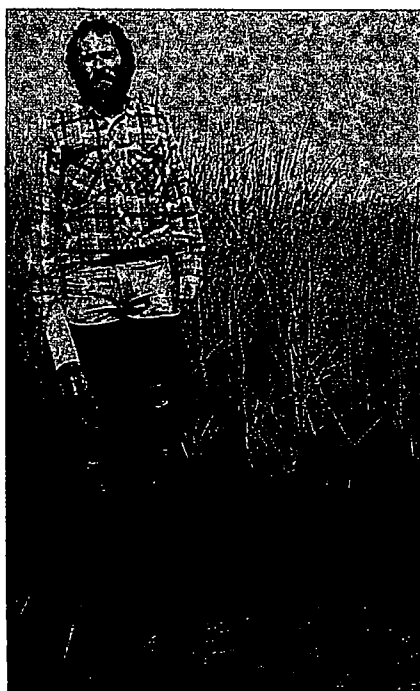


Fig. 2. USGS researcher showing the height of marsh surface above surrounding water.

contours within the needlerush marsh landscape by identifying the vegetation on aerial photography and even satellite imagery. Sand flats occupied by turtleweed and glasswort are highly visible on remote imagery and occur at the same elevation as mean high water (about 36-40 cm above mean sea level) from predicted tide tables for the area. Also highly visible is the distinct marsh-forest boundary occurring near the elevation of the highest predicted tides from the same tide tables (60-70 cm above mean sea level). These vegetation boundaries provided proxy elevation contours that were used to estimate the slope and produce an elevation gradient model of the study area. The probability of species and plant communities tolerating coastal flooding was also determined from these field surveys and used to predict changes in habitats.

Model Development

A digital elevation model of the study area was constructed to track the

process and pattern of coastal inundation over space and time for projections of sea-level rise. Model simulations were generated to predict a likelihood index of habitat change and conversion under flooded conditions for different scenarios of sea-level rise.

Sea-level rise was simulated based on a series of case projections (low, mid, and high) for the years 2000 to 2100 adopted by the Intergovernmental Panel on Climate Change (1995; Fig. 3). At these levels, major portions of the coastal zone in this region would be permanently inundated over the next century, bringing about a migration upslope of marsh habitat and a loss in the total area and proportion of forest habitats.

Results

Model results show that there is a large landbase that will be converted from marsh to open water and forest to marsh. However, due to the slope of the landform, coastal marsh is predicted to increase slightly in land cover as it migrates upslope and replaces existing forest habitat. A significant portion of coastal pinelands

that stand at or below the 1-m contour would be lost given a projected sea-level increase of 0.95 m (high) over the next century. The model predicts an effective migration of emergent marsh into forested zones, but it also indicates an overall net loss of terrestrial habitat to an open water environment.



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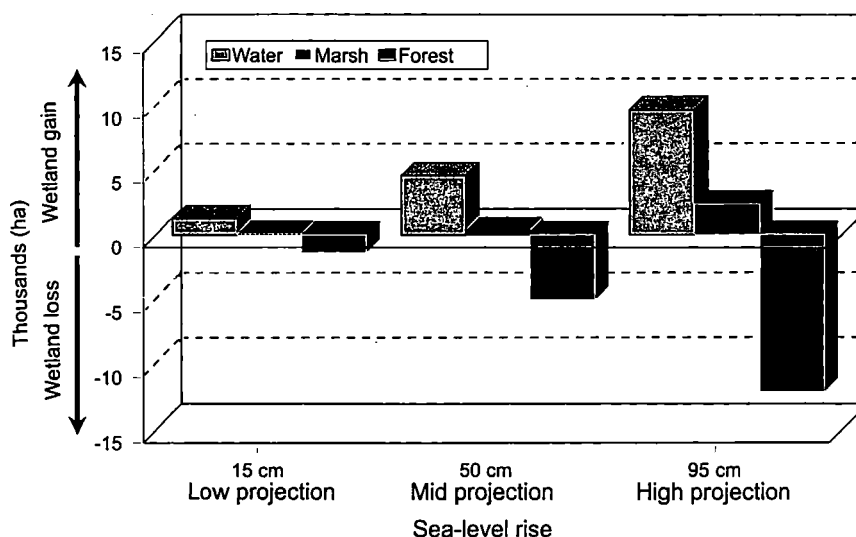


Fig. 3. Predicted changes of net loss and/or gain of open water, emergent marsh, and forest for low, mid, and high sea-level rise by the year 2100.



Predicting Coastal Flooding and Wetland Loss



The southeastern coastal region encompasses vast areas of wetland habitat important to wildlife and other economically valuable natural resources. Located on the interface between sea and land, these wetland habitats are affected by both sea-level rise and hurricanes, and possibly by hydroperiod associated with regional climatic shifts. Increased sea level is expected to accompany global warming because of higher sea temperatures and ice melt. To help determine the effects of sea-level rise on these wetlands, USGS scientists created computer models of coastal flooding and wetland loss.

These models augment field and laboratory studies by integrating our knowledge and understanding of natural and physical systems into a single framework. We examined the impacts of sea-level rise scenarios on wetland habitats of federal parks and refuges along the Gulf of Mexico. A geographic information system (GIS)-based simulation model was developed to predict ecosystem response to changing environmental conditions for wetland areas of the Big Bend region in northwest Florida. The model describes plant community sensitivity to hydrologic conditions linked with a GIS database of site characteristics, including habitat type, elevation, soils, and land use.

St. Marks Refuge

This regional model application includes the aquatic and terrestrial habitats of St. Marks National Wildlife Refuge (Fig. 1), a 65,000-acre refuge 20 mi south of Tallahassee covering parts of Wakulla, Jefferson, and Taylor counties. The refuge borders Apalachee Bay on the south, Ochlockonee Bay on the west, and Aucilla River on the east. The landscape is characterized by a relatively low elevational gradient intersected by several rivers and a number of freshwater springs and intertidal creeks. Upland pine sandhills drain into wet pine flatwoods and hardwood swamps within the freshwater zone and into tidal salt marsh and mudflats at bay's edge. Seagrass beds are

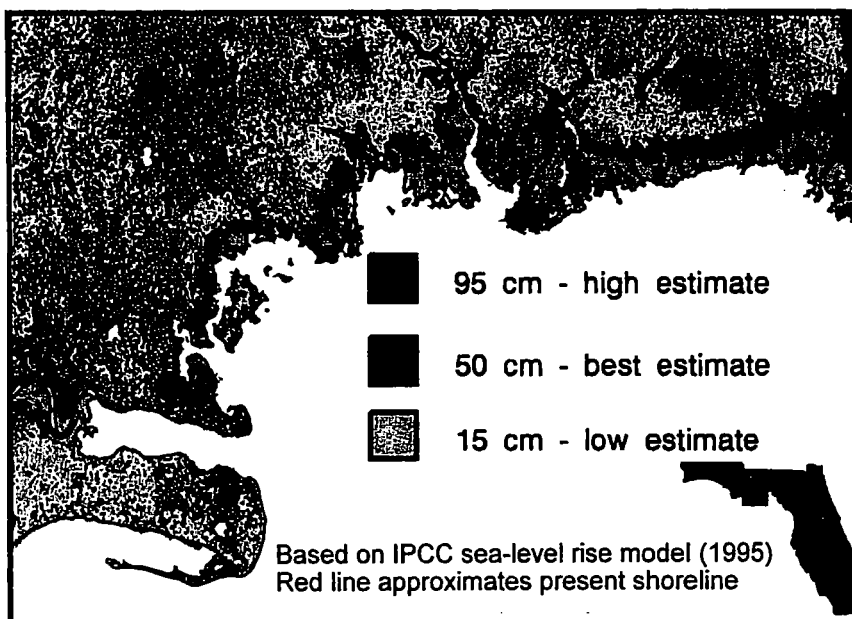


Fig. 1. Predicted shoreline changes by 2100 showing coastal inundation of the St. Marks NWR area, Florida, for low, mid (best), and high projections of sea-level rise, adopted by the Intergovernmental Panel on Climate Change.

abundant throughout Apalachee Bay, a shallow, low energy system open to the Gulf of Mexico. Elevations of these major habitat types range from below sea level for seagrass; 0-2 ft above mean sea level for salt and fresh marsh (Fig. 2); 1-4 ft above mean sea level for lowland pine, palm, hardwood hammocks; 4-6 ft above mean sea level for bottomland hardwood and pine flatwoods; and 6-40 ft above mean sea level for pine sandhill and oak associations in the higher elevations.

Field Surveys

Land elevation and tidal inundation are key factors controlling habitat type and distribution in this coastal environment. We conducted plot and transect surveys to derive a conceptual model of community types and succession under different environmental conditions and disturbance regimes. Vegetation descriptions and elevation data were collected across the forest-marsh transitional zone.

The significance of our field study was that we could plot elevation

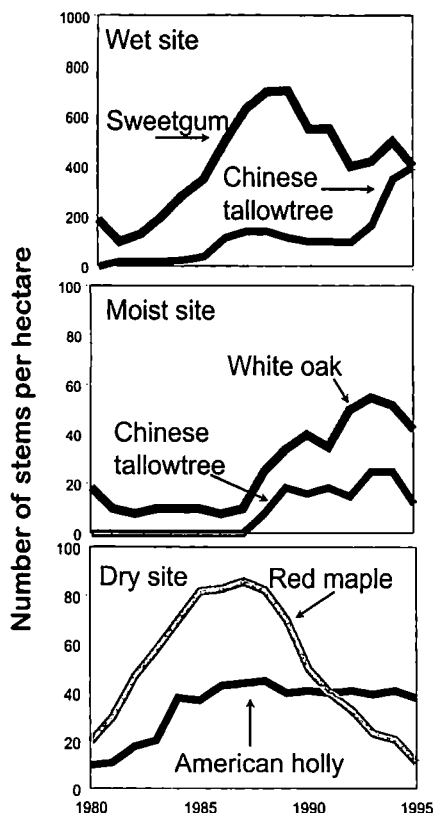


Fig. 3. Small sapling abundance.

avored sapling survival, resulting in an overall eightfold increase in sapling abundance and strongly altering the open understory that is characteristic of many bottomland forests. Altered river flows may also be predisposing this system to uncharacteristic increases of certain tree populations; these increases are then followed by catastrophic declines after unusual floods. Changes in regional climate will further increase this variability if they increase the frequency and intensity of both floods and droughts. Increasing variability of this type could result in altered ecosystem function in wetland forests and could also influence success of post-harvest regeneration in commercial forestry operations.

At the dry study site, the changes in sapling abundance were related to the history of human activity (logging and fire exclusion). Future effects of climatic changes on sites such as this will probably involve interactions between climate and fire regimes.

Changes in climate influence both within-season timing and intensity of fires, even under managed conditions, thus affecting forest composition.

Effects of Storm Disturbances

At the moist site, researchers directly observed the effects of a 1986 hurricane. Even though it caused only a small rise in mortality of canopy trees, this storm had an important impact on the forest by creating canopy openings which promoted growth of a non-native woody species, as well as several native species. If large storms begin to occur with increasing frequency, however, small trees and shrubs may benefit most, with detrimental consequences for canopy tree regeneration. This suppression of tree regeneration, coupled with higher storm-related mortality, could result in a long-term decline in the carbon storage capacity of southern upland forests.

Influence of Climatic Fluctuations

Researchers tested for variability in growth of trees and saplings over short and long time periods and small and large areas that might be related to climatic fluctuation. The emerging conclusion is that climate variation does produce small but detectable effects on tree and sapling growth in natural forests. However, subtle climatic variability does not seem to affect recruitment or mortality, though earlier work showed that drought strongly increased seedling mortality in the wet forest. Failure to detect effects on tree mortality may be related to the fact that trees die slowly and that multiple causes are often involved. Continued collection of these important data over the next 10-20 years will more definitively show how climate affects tree recruitment and mortality.

Climate Change Will Affect Southeastern Forests

Overall, evidence from the long-term monitoring indicates that climate

change will affect individual growth rates directly by way of overall warming or change in regional moisture balance. Climate shifts will also affect death and recruitment rates indirectly by altering the frequency and intensity of stand disturbances. Results suggest that disturbance effects are stronger and more immediate than growth effects. Because individual trees grow quickly and species are not particularly long-lived, responses to climatic change may be rapid. In natural area preserves, Chinese tallowtree and other non-native woody species will become more important if disturbances increase. In commercially managed forests, increasing disturbance rates may result in higher timber losses.

The variety of spatial and temporal influences on forest processes, coupled with uncertainties associated with climate prediction, makes it difficult to assess the effects of changes in climate on forest dynamics at the ecosystem level. Nevertheless, this research not only identifies specific climatic effects on particular life stages or processes, but it also provides critical information for improving our understanding of the context within which these effects occur.



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Effects of Climate Change on Southeastern Forests



Forests of the coastal plain region of the southeastern United States are among the most productive in North America. Because they form the basis of a large timber and wood products industry, these forests are of considerable economic importance. Also, the forests are rich in plant and animal species. Because they are diverse as well as productive, they have considerable conservation importance. Therefore, understanding potential impacts of climate change on southern forests is critical.

Scientists from Rice University sponsored by the National Wetlands Research Center are using a long-term study of forest structure and change in east Texas to investigate potential effects of climate change on forests of the coastal plain (Fig. 1). Study areas include sites in the Big Thicket of east Texas, which are representative of important vegetation types on the coastal plain, including bottomland hardwoods, one of the two major types of forested wetlands in the region. Unique records of forest variation have been created for three study sites. The database includes records on more than 42,000 individual trees.

Tree-ring Studies

In addition to the long-term study, they use tree-ring measurements and weather data to reconstruct past relationships of tree growth to climate and to investigate species behavior near range limits. Annual tree-ring chronologies have been developed from 16 tree species growing on 38 sites distributed across the region. Initial results of tree-ring measurements indicate that individual growth is not substantially slower near the range boundary of a species, which implies that species range boundaries in this region are not set by climatic limitations on individual growth. Thus factors influencing reproduction may be more critical in setting range limits. Also, analysis of the relationship of tree-ring width to climate revealed



Fig. 1. Rice University researcher measuring tree growth at Big Thicket National Preserve.

another surprising result: several groups of related species (black oaks, white oaks, and pines) respond differently to climate. This fact indicates that groups will respond differently to climate change, and therefore the relative importance of these groups in forests may change. This kind of information is presently only possible to obtain through tree-ring analysis.

Effects of Flooding and Fire

Long-term studies reveal that Big Thicket forests can show strong variation in tree mortality over time (Fig. 2). Flooding at the wet site in 1989-92 initiated a strong pulse of mortality. At the moist upland site, a hurricane caused a mortality peak in

1987 that was about three times the long-term average. Variations in abundance of saplings of some species (Fig. 3) are partially explained by these disturbances. For example, Chinese tallowtree, an exotic species, took advantage of the disturbance openings to invade the wet and the moist upland sites. Also, other species increased in abundance following the disturbances. Nevertheless, not all of the trends in saplings were related to these disturbances. At the wet forest site, it appears that changes in the river flow related to construction of two upstream dams much earlier

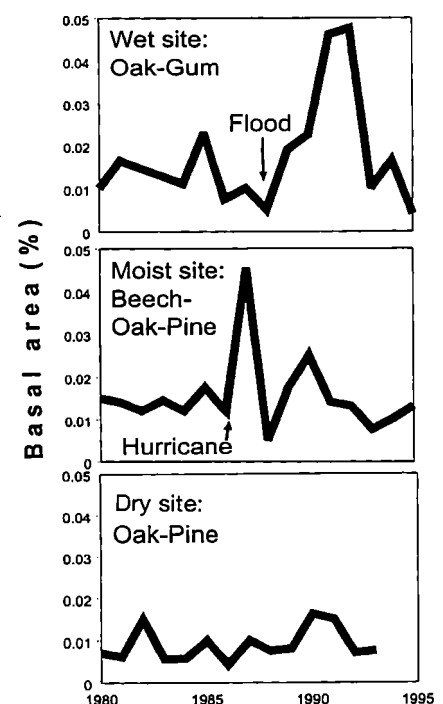


Fig. 2. Natural forest mortality.

Invasive Species

Research sponsored by the National Wetlands Research Center and conducted by Clemson University scientists compared salinity tolerances of baldcypress and an invasive exotic species, Chinese tallowtree (*Sapium sebiferum*). Greenhouse experiments were conducted to determine survival, height and diameter growth, and biomass accumulation of the two species when subjected to flooding and various salinity levels of 0, 2, and 10 parts per thousand; seawater averages about 35 parts per thousand. Seedlings of both species survived to the end of the 3-month experiment, except for those flooded with 10 parts per thousand salinity. Baldcypress seedlings died within 2 weeks of flooding in the 10 parts per thousand treatment, while Chinese tallowtree seedlings survived up to 6 weeks. Surviving baldcypress seedlings from the other treatments exhibited more variability in diameter than did Chinese tallowtree, but growth was not significantly affected in either species. However, this study suggests that as salinity and flooding along coastal areas increase, Chinese tallowtree may outcompete baldcypress for available habitat, particularly in seasonally flooded areas.

Salt Tolerance

Salinity tolerance studies at the National Wetlands Research Center investigate the feasibility of developing saltwater-tolerant baldcypress strains. Greenhouse and field studies identify genetically suitable families of salt-tolerant baldcypress for future plantings. Researchers collected and germinated baldcypress seeds from brackish to freshwater areas in coastal Alabama, Louisiana, and Mississippi (area salinities ranged from 0.1 to 7.5 parts per thousand). A total of 2,700 seedlings was used in the greenhouse study and placed into treatments of 0, 2, 4, 6, and 8 parts per thousand. Measurements of seedling survival, height, diameter, and physiology were

monitored (Fig. 3). Field studies of these same families, planted in saltwater-impacted areas, were undertaken and completed in the autumn of 1996. Measurements of the trees at these sites will continue to be made periodically.

Possible Restoration

Information from these and other studies indicate that some baldcypress trees have a higher level of salinity and flooding tolerance than the general population of baldcypress. Individuals from mature trees in brackish waters proved to have higher survival and achieved greater growth in saltwater treatments than seedlings from freshwater areas. These tolerances for inundation and salinity are apparently transferred to offspring.

Research such as this may make it possible to restore baldcypress stands in areas impacted by increased salinity and flooding.

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Fig. 3. Measuring baldcypress response in salinity treatments.



Salt Tolerance of Southern Baldcypress



Historically, cypress-tupelo swamps covered much of the low-lying coastal regions of the Southeast. However, saltwater intrusion and increased flooding over the past 30 years, combined with past logging, have depleted the numbers and decreased the survival and growth of baldcypress (*Taxodium distichum*) in coastal areas along the Gulf of Mexico.

Cypress-tupelo swamps provide numerous benefits, ranging from wildlife habitat (in south Louisiana, bald eagle nests were found in cypress-tupelo forests 93 % of the time) to forest products (baldcypress lumber is valuable for its rot resistance). These forests also help protect many natural and developed areas by absorbing wind and water energy from hurricanes. After a hurricane, tree survival in cypress-tupelo swamps is much higher than for other hardwood forests in coastal areas.

Threats to Baldcypress

The volume of baldcypress timber in Louisiana, however, was reduced from 49 million board feet in 1948 to four million board feet in 1977, mostly due to logging. Many cypress swamps logged 30-100 years ago have not regenerated. Also, subsidence and saltwater intrusion have caused the formation of "ghost swamps" or "cypress cemeteries" covering hundreds of hectares (Figs. 1-2).

Flooding from severe hurricanes, submergence associated with local subsidence and sea-level rise, and salinity influences from canals dug in the coastal zones have significantly contributed to the destruction of baldcypress swamps. In addition, many of these areas are now being invaded by exotic and undesirable species of trees that are less able to survive hurricane-force winds and therefore provide less protection to adjacent areas.

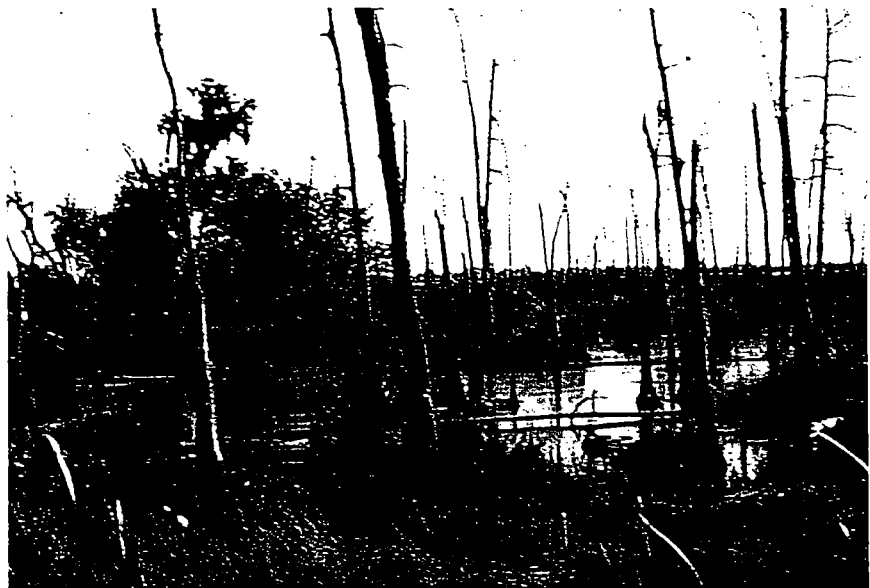


Fig. 1. "Ghost Swamp," Terrebonne Parish, Louisiana.

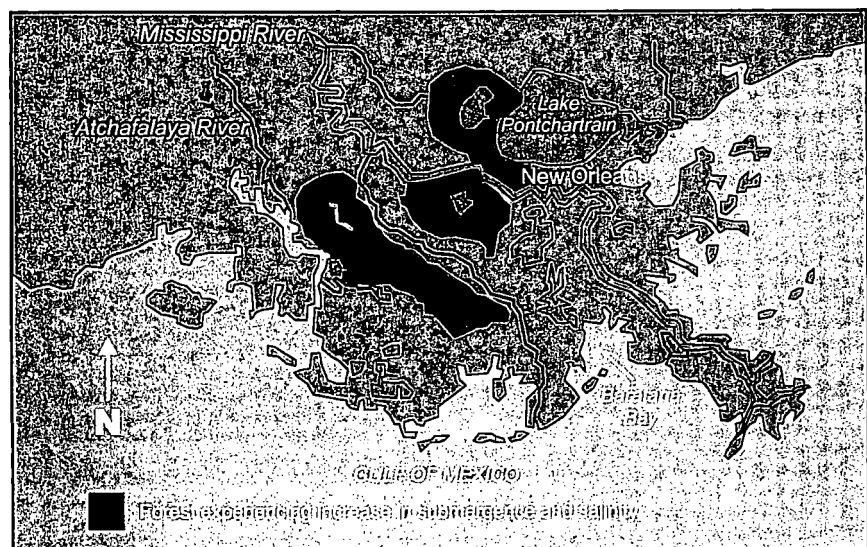


Fig. 2. Coastal Louisiana forest experiencing increase in submergence and salinity.

Determining Potential for Marsh Submergence

Traditionally, the potential for marshes to become submerged has been determined by comparing the rate of **vertical accretion** (surface sedimentation) to the rate of relative sea-level rise. If accretion lags behind sea-level rise, then an **accretion deficit** exists and the potential for submergence is high. The concept of accretion deficit assumes that vertical accretion equals marsh elevation change. Yet we know that marsh surfaces sink as a result of subsidence (Fig. 1). Therefore, we tested this assumption by simultaneously measuring both vertical accretion and marsh elevation (Fig. 2). If the assumption were false (i.e., if elevation gain were less than vertical accretion), the accretion deficit would underestimate the potential for submergence. Therefore, the elevation data would be used to calculate an elevation deficit, which would give a more accurate estimate of the potential for submergence. In addition, we made the measurements with a level of accuracy sufficient to distinguish between the influence of surface sedimentation and subsurface soil processes (e.g., root growth and soil

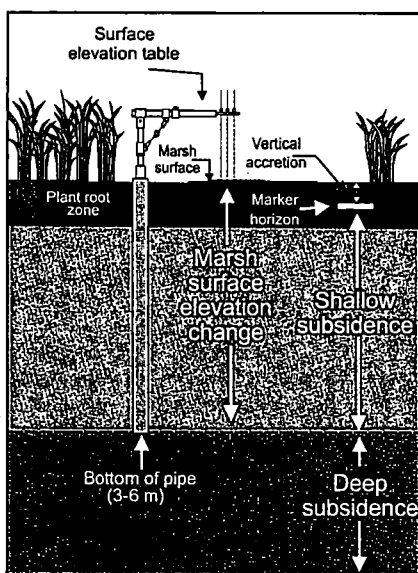


Fig. 2. Methods used to measure marsh elevation change and shallow subsidence.

compaction) on soil elevation. This approach allowed us to determine for each locale whether surface or subsurface processes were controlling elevation.

After at least 2 years of measurements, accretion and elevation were not equal at a majority of the 12 marshes we studied. **Shallow subsidence** (the difference between vertical buildup and the effects of surface and subsurface processes on elevation) at these marshes typically ranged from 3 to 4 mm/yr. These findings indicate that soil processes occurring below the marker horizon had as strong or stronger an influence on elevation than surface sedimentation. Therefore, accretion deficits for these marshes underestimated the potential for submergence. This potential was best estimated by elevation deficits. The processes which controlled elevation included sedimentation, plant root growth, decay of plant matter in the soil, water storage/drainage, and soil compaction. Natural forces driving these processes included seasonal patterns in hydrology and major storms.

Findings from a submerging marsh at Bayou Chitigue, Louisiana, provide an excellent example of the processes influencing elevation (Fig. 3). The relative sea-level rise rate for this marsh is 1.38 cm/yr, estimated from local tide gauges. For 4 years, vertical accretion averaged 2.07 cm/yr, suggesting that marsh elevation was keeping pace with sea-level rise. However, elevation remained virtually unchanged. The persistence of the

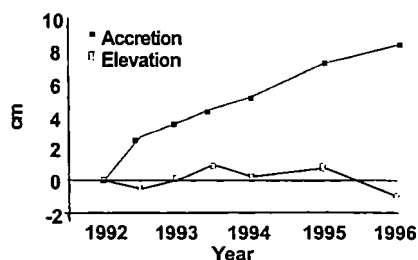


Fig. 3. Comparison of accretion (soil buildup) and elevation at Bayou Chitigue, Louisiana.

marker horizon and high rate of accretion indicate that the lack of elevation gain was not caused by erosion. Therefore, the lack of elevation gain must be caused by sinking of the marsh surface from shallow subsidence, as indicated by the distance between the two lines in Figure 3. The accretion data alone gave a misleading indication of the potential for submergence. The simultaneous accretion and elevation data indicate that the marsh surface moved downward 2.28 cm/yr. Estimates of sea-level rise from tide gauges do not include shallow subsidence. Therefore, the actual relative sea-level rise rate for this marsh is 3.66 cm/yr ($1.38 + 2.28$), which explains why the marsh is rapidly submerging.

The existence of shallow subsidence does not always mean that an elevation deficit exists. A study in south Florida found that both fringe and exposed island mangrove forests experienced significant shallow subsidence but soil elevation kept pace with sea-level rise. The sheltered island studied, however, appears to be experiencing an elevation deficit.

Conclusions

The potential for submergence of some coastal marshes is best determined by calculating elevation deficits rather than accretion deficits. Moreover, measures of total subsidence based on tide gauge records are underestimated by the amount of shallow subsidence. Trends in elevation of coastal marsh cannot be extrapolated among sites, and site-specific data are required to develop appropriate management practices.

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Global Warming, Sea-level Rise, and Coastal Marsh Survival



Coastal wetlands are among the most productive ecosystems in the world. These wetlands at the land-ocean margin provide many direct benefits to humans, including habitat for commercially important fisheries and wildlife; storm protection; improved water quality through sediment, nutrient, and pollution removal; recreation; and aesthetic values. These valuable ecosystems will be highly vulnerable to the effects of the rapid rise in sea level predicted to occur during the next century as a result of global warming.

A coastal wetland becomes submerged and disappears if sea level rises faster than the marsh surface builds up. Hence, determining the potential for submergence is a critical first step for managing these valuable coastal habitats in the next century. Research conducted by U.S. Geological Survey scientists has improved our understanding of the natural processes controlling wetland elevation and the potential for submergence of our coastal wetland habitats.

Sea-level Rise

There are two processes by which sea level can increase relative to the marsh surface: (1) sea level rises because of increases in the volume of the oceans, and (2) the marsh surface sinks because of soil compaction and other geologic processes (collectively called **subsidence**). The volume of the oceans increases as global warming thermally expands seawater and melts glaciers, resulting in a global change of sea level. The rate of global sea-level rise is expected to accelerate during the next century as atmospheric temperatures continue to increase. Sinking of the soil surface occurs in nearly every marsh but varies greatly among locales. River deltas with thick, unconsolidated sediment deposits, such as the Mississippi River delta, have high rates of sinking, while coastal fringe marshes with thin sediment deposits have low rates of sinking. Global sea-level rise and local marsh surface

sinking occur simultaneously, and their combined effect is referred to as **relative sea-level rise**. Vulnerability to relative sea-level rise and to coastal submergence varies greatly among marshes because of local variation in marsh sinking rate, indicating that site-specific information is needed to develop appropriate management strategies for each wetland.

Coastal Marsh Response

There are two processes by which marshes build vertically: surface sediment deposition (**sedimentation**) and subsurface accumulation of live plant roots and decaying plant parts (Fig. 1). Both processes are controlled by marsh flooding (hydrology) and both contribute to soil volume, which directly influences surface elevation. Flooding patterns control the delivery of sediment to the marsh surface and the oxygen content of the soil, which

influences the rate of plant growth and decay. Sedimentation enhances plant growth by delivering plant nutrients to the soil while vegetation enhances sedimentation by trapping sediments suspended in flood waters. Hence, a rising sea level can influence all of these processes by changing flooding patterns. In a healthy marsh under a moderate rate of sea-level rise, marsh elevation increases at the same rate as sea-level rises and the flooding patterns remain unchanged. In a deteriorating marsh or under an accelerated rate of sea-level rise, plant growth is reduced because of excessive flooding, and soil volume cannot keep pace with subsidence and sea-level rise. As elevation lags further behind relative sea-level rise, the plant stress increases until the plants die, the soil volume collapses, and the marsh becomes submerged.

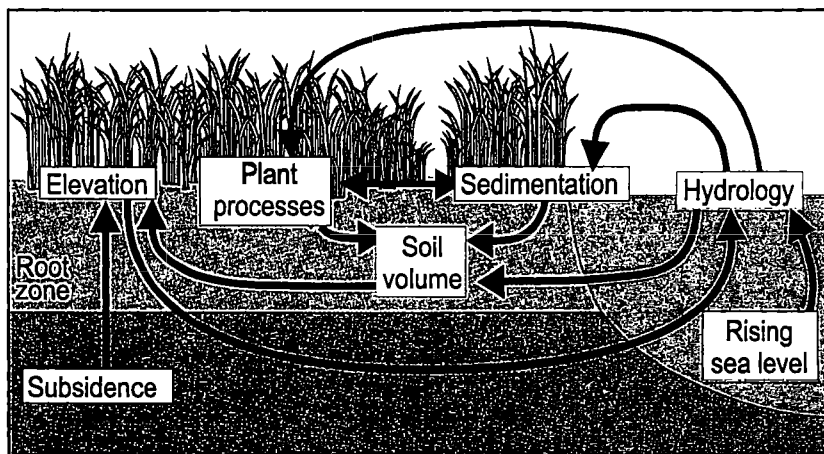


Fig. 1. Relationships influencing marsh elevation.

Photosynthetic capacity increased by as much as two to eight times ambient levels during certain times of the year in three freshwater species—wild-celery (*Vallisneria americana*), coontail (*Ceratophyllum demersum*), and hydrilla (*Hydrilla verticillata*)—and in a seagrass species, shoalgrass (*Halodule wrightii*). Only widgeon grass (*Ruppia maritima*) from an area rich in dissolved carbon did not respond to additions of carbon dioxide. Alteration of photosynthesis can lead to changes in plant growth, which may disrupt species dependent on these aquatic plants by altering plant biomass and seasonal timing of biomass availability.

Elevated Carbon Dioxide and Growth of Submerged Vegetation

Freshwater wild-celery and shoalgrass were grown for 6 weeks in mesocosms (Fig. 2) receiving four times the atmospheric concentration of carbon dioxide. While biomass did not increase in either species, other effects were found. Biomass of epiphytes (plants depending on another plant for mechanical support) on shoalgrass increased significantly. Excess epiphytic growth has been shown to reduce light to plants so



Fig. 2. Wild-celery and shoalgrass mesocosms receiving enhanced atmospheric concentrations of carbon dioxide.

much that the host plant cannot survive. Both species produced more root and rhizome biomass relative to leaf biomass. This change in biomass production suggests that climate change would favor grazing organisms that preferentially consume below-ground tissue. Leaf tissues of wild-celery had higher ratios of carbon to nitrogen than plants grown under normal carbon dioxide concentrations. High carbon-to-nitrogen ratios tend to provide poorer quality forage for

consumer organisms such as wintering waterfowl.

Effects of Increased Salinity

As sea level rises, many communities of fresh and brackish submerged aquatic vegetation will experience salinity increases. In some cases, an inland migration of communities might be possible, but in other cases salinity stress will change the community composition. Where salinities increase from freshwater to oligohaline (0.5-5.0 parts per thousand), community composition will be dominated by species which are strong competitors for light, nutrients, and other factors. Two nuisance exotic species, milfoil (*Myriophyllum spicatum*) and hydrilla, often outcompete other species at low salinities (Table). Increased hydrilla can lower water quality and oxygen concentrations, possibly causing fish kills. Under mesohaline (5-18 parts per thousand salinity) conditions, community structure will be strongly governed by the salinity tolerances of the species. Salt-tolerant species such as wild-celery, widgeon grass, and sago pondweed (*Potamogeton pectinatus*) are predicted to dominate submerged aquatic vegetation communities at higher salinities. Salinity-induced changes in community composition will induce changes in animal communities adapted to specific plant associations.

Table. Potential changes in community composition of various species of submerged aquatic vegetation as a result of increased salinity. Given this assemblage of species, those species marked with an asterisk are expected to dominate the community.

A. Potential community composition determined from maximum salinity tolerances of individual species. An X indicates species presence at the given salinity.

	Salinity ‰			
	0	4	8	16
Hydrilla	X	X		
Grassleaf mud-plantain	X	X	X	
Milfoil	X	X	X	X
Wild-celery	X	X	X	X
Sago pondweed	X	X	X	X
Widgeon grass	X	X	X	X

B. Predicted community structure based on salinity tolerance and competitive performance.

	Salinity ‰			
	0	4	8	16
Hydrilla	*	X		
Grassleaf mud-plantain	*	*	X	
Milfoil	*	*	X	X
Wild-celery	X	*	X	X
Sago pondweed	X	X	*	*
Widgeon grass	X	X	*	*



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Global Change and Submerged Aquatic Vegetation Research



Communities of submerged aquatic vegetation (SAV) are important components of many freshwater, brackish, and marine aquatic ecosystems. They prevent erosion by baffling the impacts of waves, especially from storms. These aquatic plant communities remove nutrients and other pollutants from river and runoff inputs to coastal areas, preventing their entry into surrounding waters. They provide nursery habitat for fish, shrimp, and other species, as well as forage for wintering waterfowl and endangered species such as sea turtles and manatees. Unfortunately, not only have the distribution and abundance of seagrasses in the northern Gulf of Mexico declined precipitously during the past 50 years, most notably from widespread deterioration of water quality, but submerged aquatic plant communities are also susceptible to long-term environmental changes that are predicted to accompany global climate change.

The direct effect of temperature on plant physiology may ultimately influence community composition and latitudinal species occurrence. Increases in the concentration of dissolved inorganic carbon, including both carbon dioxide and bicarbonate, may affect submerged plants directly and may have indirect effects by increasing the growth of attached and suspended algae.

Global sea level has risen between 10 and 25 cm over the past 100 years. The Intergovernmental Panel on Climate Change (IPCC, 1995) expects that average sea level will continue to increase as a result of thermal expansion and melting of glaciers and ice sheets. Models using the IPCC's "best estimate" values of climate sensitivity and ice melt suggest an increase in sea level of about 50 cm from the present to 2100. Continued rise in sea level will increase the depth of coastal waters and will cause inland and upstream salinity intrusion, both of which will affect submerged vegetation. While there is uncertainty regarding the influence of global warming on the frequency and intensity of storm events, sea-level rise alone has the potential for increasing the severity of storm surge, particularly in areas where coastal habitats and barrier shorelines are

rapidly deteriorating.

Research has begun to yield information on the responses of submerged aquatic vegetation communities to some of the environmental consequences expected to accompany global change.

Seagrass Disturbance

Overwashes from storms frequently deposit sandy sediments in seagrass beds growing leeward or behind protective barrier islands, such as the Chandeleur Islands of Louisiana (Fig. 1). In Chandeleur Sound, turtlegrass (*Thalassia testudinum*) inhabits nutrient-rich protected areas, while manatee grass (*Syringodium filiforme*) dominates sandy areas subject to frequent overwash. Increased storm disturbances and overwash will alter the community composition of gulf seagrass beds by promoting increases in the abundance of manatee grass. Since different species of seagrass support different food webs, changes in the community composition of seagrasses will be propagated into changes at higher levels in the food chain.

Frequent severe overwash and barrier island erosion may even lead to total loss of all seagrasses from an area.



Fig. 1. Storm overwash fan deposited on a seagrass bed in the Chandeleur Islands, Louisiana.

Effects on Plant Photosynthesis

As atmospheric carbon dioxide increases with global change, concentrations of dissolved carbon dioxide and bicarbonate are expected to increase in aquatic ecosystems. The photosynthetic responses of some submerged aquatic vegetation species to additions of carbon dioxide were measured in the laboratory.

USGS Global Change Wetlands Research

The following projects were recently awarded funding in December 1998.

Total Funding: \$1.278M/year, Project Duration: 3-5 years

Coastal Dynamics -Sea Level Rise

Response of Coastal Ecosystems to Sea-Level Rise: Assessing Wetland Elevation Changes, Potential for Submergence, and Management Options. Don Cahoon , National Wetlands Research Center

Experimental Studies of the Effects of Elevated CO₂ on Production - Decomposition Processes in Gulf Coast Marshes Karen McKee, National Wetlands Research Center

Understanding and Predicting Global Climate Change Impacts on the Vegetation and Fauna of Mangrove Forested Ecosystems in Florida. Tom Smith, Florida Caribbean Science Center

Relative Sea-level Rise, Marsh Island Dynamics, and Potential Impact on Atlantic Coast Migratory Bird Species and Their Habitats. Michael Erwin, Patuxent Wildlife Research Center

Coastal/Wetlands Modeling

Modeling and Monitoring Global Change Effects on Submerged Aquatic Vegetation of Intermediate Salinities along the Gulf of Mexico Coast. Jacoby Carter, National Wetlands Research Center

Effects of Global Climate Change on Great Lakes Wetlands. Douglas Wilcox, Great Lakes Science Center

Integrating the Effects of Land Use and Global Climate Change on Hydrology and Vegetation of Northern Great Plains Wetlands

Coastal Dynamics - Sea Level Rise

Project Summary

Project Title: Potential Effects of Elevated CO₂ and Interactions with Salinity on the Structure and Function of Coastal Marshes

BRD Principal Contact: Karen L. McKee, P.hD.

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Duration of project: 5 years

Annual funding requested from GC program: \$ Y1=194.5k, Y2=82.5k, Y3=73k, Y4=87.5k, Y5=85.5k

Total funding requested from GC program: \$523k

Biogeographic Feature/Region:
(coastal areas)

Thematic area:
(coastal dynamics, sea-level rise)

Key words: below-ground dynamics, decomposition, elevated CO₂, marsh, nutrient uptake kinetics, organic matter accumulation, productivity, resource allocation, rhizome, root turnover, salinity, sea-level rise, subsidence

Abstract: Coastal wetlands throughout the United States and the world are vulnerable to rising sea-level, which may be accelerated by global warming. In addition to eustatic sea-level rise, some areas are undergoing rapid rates of subsidence, which adds to the potential for submergence of coastal ecosystems. Accurate estimates of this process are essential to our ability to predict the effects of global sea-level rise and local subsidence in coastal zones and to develop sound management practices. Although input of inorganic sediment counteracts these effects by increasing surface elevations and is often emphasized in management schemes, the contribution of organic matter to vertical accretion is also important, especially in sediment-poor habitats. Because deposition of organic matter is affected by a complex suite of biotic and abiotic factors, many variables must be studied interactively to fully understand how global climate change may alter the processes that control organic matter contribution to vertical accretion in coastal wetlands.

One important global change factor that can directly affect plant communities is atmospheric carbon dioxide (CO₂) concentration. The concentration of CO₂ in the atmosphere is increasing and expected to double during the next century. Future elevated CO₂ concentrations may differentially affect relative abundance as well as production and decomposition of marsh plant species. An understanding of how elevated CO₂ might

impact coastal marshes is limited by a lack of information regarding responses by dominant species at subtropical latitudes and interactions between CO₂ and edaphic factors controlling growth and distribution of wetland vegetation.

I propose to use a combined approach to assess responses of saline, brackish, and fresh marsh community types to elevated CO₂. Long-term effects of CO₂ treatment and interaction with salinity will be determined over a three-year period in replicate greenhouses with marsh mesocosms containing intact swards of vegetation in a natural substrate. Changes in plant morphology, biomass partitioning, and chemical composition will also be evaluated, and the plant material produced under elevated and ambient CO₂ will be used to determine decomposition rates in the field, under natural conditions (the objective is to assess effects of differences in plant material generated by CO₂ treatment, rather than effects of CO₂ on decomposers). Changes in soil surface elevation and vertical accretion will also be monitored in the mesocosms and used to calculate shallow subsidence (accretion minus elevation change); the results will be used to estimate the effects of elevated atmospheric CO₂ on ability of marshes to keep pace with sea-level rise. A final objective is to determine how the distribution of carbon and nitrogen between primary and secondary shoots of rhizomatous plant systems (which predominate in coastal marshes) will be altered by CO₂ enrichment, and if this change will increase the efficiency with which a species can expand into substrates with low nutrient availability.

The proposed project will directly contribute to the long-term goals of the BRD Global Change Research Program by determining sensitivity and response of coastal wetland ecosystems to future atmospheric CO₂ levels (Goal 1). The results can be used to predict how the structure and function of coastal wetlands on Federal lands and elsewhere may be altered in the future (Goal 2). The proposed experimental approach will specifically determine causal mechanisms underlying wetland ecosystem responses to global change in CO₂ concentrations. This project will be beneficial to U.S. coastal communities, industries, and resource managers because the results will allow a more accurate estimate of the potential for submergence of coastal wetlands, improve predictions about the effects of global sea level rise and subsidence processes, and lead to better management practices that aid in maintenance and restoration of our coastal wetlands (Goal 3). Although the project will be conducted with vegetation types common to the Gulf Coast, the benefits will accrue to all other coastal states whose marshes are dominated by the same species. The results will also be applicable in a relative sense to other coastal areas, since the processes involved also occur in other wetland systems. Interactive effects of CO₂ and salinity on wetland species responses will also indicate how CO₂ enrichment may, in general, modify plant responses to stress. Examination of resource allocation and nutrient uptake kinetics by rhizomatous wetland species will provide insight into how clonal species, in general, may be affected by CO₂ enrichment.

Project Summary

Project Title: Response of Coastal Ecosystems to Sea-level Rise: Assessing Wetland Elevation Changes, Potential for Submergence, and Management Options

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Duration of project: 5 Years

Annual funding requested from GC program: \$ Y1 = 300k
Y2-Y5 = 330k/year

Total funding requested from GC program: \$ 1,620k

Biogeographic Feature/Region

Thematic Area

Coastal Areas, Islands

Coastal Dynamics, Sea-Level Rise

Key words: tidal marsh, mangroves, sedimentation, plant growth/decomposition, vertical accretion, elevation change, shallow subsidence, sea-level rise, accretion deficit, elevation deficit

Abstract: There is a critical need to acquire information that will enable scientists and managers to better predict the vulnerability of coastal wetlands to submergence caused by sea-level rise and to evaluate the effect of current management and restoration practices on wetland elevation change and submergence. Global mean sea level has risen approximately 1-2 mm/yr during the past 100 years (Gornitz 1995) and the Intergovernmental Panel on Climate Change (IPCC) predicts this rate of rise will increase 2-5 times by the year 2100 (Watson et al. 1996). These estimates do not include sea-level rise caused by local factors other than global warming (e.g., land subsidence). Hence, the potential for submergence of coastal marshes/mangrove forests is controlled not only by the trend in local mean sea level but also by the local environmental factors of relative sea-level rise, coastal geomorphology, sediment supply, and frequency of major storms (Gornitz 1995).

The potential for coastal wetland submergence has traditionally been determined by comparing rates of vertical accretion directly to local rates of relative sea-level rise and calculating accretion deficits (Stevenson et al. 1986). This technique assumes that vertical accretion is equal to wetland elevation change, yet the marsh surface can subside for a variety of reasons, including compaction, growth faulting and compaction of deep sediments, subsurface fluid withdrawal, and hydrologic alterations such as impoundments. Under the GCRP, Cahoon et al. (1995) tested this assumption directly with an innovative method of measuring accretion and elevation change

simultaneously, and they demonstrated that the accretion deficit approach underestimates the potential for submergence of some wetlands. The difference between accretion and elevation is called shallow subsidence. The research indicated that the amount of shallow subsidence was site-specific and could not be readily extrapolated to other sites, a variety of subsurface processes likely influenced elevation, and major storms could compact the marsh surface. Consequently, in order to manage our coastal ecosystems during future sea-level rise, we need information on (1) shallow subsidence from a broader range of environmental and geographic settings, (2) the critical processes controlling elevation in each environmental setting (e.g., plant growth-decomposition, pore water storage, and compaction), (3) the natural forces driving the processes controlling elevation (e.g., the role of episodic events like major storms), (4) the reliability of long term extrapolations of elevation deficits (i.e., determined from analysis of long term elevation records and predictive models), and (5) the influence of management practices (e.g., burning, hydrologic manipulations, and sediment introduction) on shallow subsidence and the potential for marsh submergence.

The proposed project will address the following objectives: (1) establish a comprehensive geographic network of elevation monitoring sites on Federal coastal wetlands to give an advance warning of change, (2) determine the long-term potential for submergence of Federal coastal wetlands through modeling, (3) establish standard measurement protocols among the coastal wetland research community to make data from different sites comparable and allow for evaluation of global trends in the vulnerability of coastal wetlands to submergence, (4) determine the critical subsurface processes (biological, hydrological, and geological) controlling elevation change in coastal wetlands to enable development of appropriate management strategies, and (5) determine the impact of current wetland management and restoration practices on wetland elevation changes and the ability of the wetlands to build vertically at a pace equal to relative sea-level rise. The proposed project will address BRD 5-year and long-term goals by determining (1) the sensitivity of coastal wetland ecosystems to sea-level rise (Goal 1), underlying causal mechanisms controlling elevation change in coastal wetlands (Goal 2), and (3) effectiveness of management practices at minimizing the undesired effects of rising sea level on coastal ecosystems (Goal 4).

Project Summary

Project Title: Understanding and predicting global climate change impacts on the vegetation and fauna of mangrove forested ecosystems in Florida.

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Duration of project: 5 years

Annual funding requested from the GC program: \$200,000
Total funding requested from the GC program: \$1,000,000

Biogeographic Feature / Region(s)	Thematic Area(s)
Coastal areas, Islands, and Coral reefs	Coastal dynamics, sea level rise
Forests	Disturbance (severe storms, fire, flood)
	Watershed response, hydrology

Key words: mangrove, forest, sea level rise, fire, nekton, hydrology, groundwater, hurricanes, fish

Abstract: The occurrence, causes and effects of change in mangrove forested wetlands are addressed in this project. The affects of vegetation change on use of the mangrove ecosystem by important sport and commercial species of nekton will be studied. Primary sites for this research will be on DOI trust lands in south Florida including Everglades, Biscayne and Dry Tortugas National Parks, and the Ten Thousand Island, Ding Darling, Key Deer and Great White Heron National Wildlife Refuges. Archival aerial photographs will be used to address global change on the scale of decades. Important causal mechanisms are hypothesized to by sea level rise, hurricanes, and the interaction of hydrology and fire at the mangrove forest / marsh ecotone. An important human component which may have exacerbated rates of change is upstream water management. Study sites will be selected such that each of these factors can be addressed. Data collection will take the form of both observational and experimental studies. Extensive use will be made of BRD research facilities already in place. These include a 16 station ground and surface water sampling network which spans the upstream (freshwater marsh) to downstream (mangrove forest) gradient on three tidal rivers on the SW coast of Everglades NP. Associated with the hydrological sampling sites are more than 100 permanent vegetation monitoring plots in mangrove forest and marsh communities. Recently sedimentation / elevation tables have been installed to measure rates of sediment elevation change. These three types of sampling stations have been colocated to maximise their scientific utility. Our nekton sampling schemes and vegetation experiments will take advantage of this network of stations to expand our knowledge of global change causes and consequences in the mangroves of south Florida.

Project Summary

Project Title: Relative sea level rise, marsh island dynamics, and potential impacts on Atlantic Coast migratory bird species and their habitats

BRD Principal Contact: R. Michael Erwin

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Duration of project: 5 years

Annual funding requested from GC program: \$98.4 - 147.1 K

Total funding requested from GC program: \$ 638.7 K

Biogeographic Feature/Region: Coastal areas

Thematic Area: Coastal dynamics and sea level rise

Key words: sea level rise, Atlantic coast estuaries, marsh islands, subsidence and accretion, migratory waterbirds, feeding habitat, nesting habitat, roosting, surveys, landscape changes, modeling

Abstract: Coastal managers in the United States have mounting concerns about the rate of relative sea level rise and the abilities of our coastal wetlands to maintain their integrity and quality, especially when increasing numbers of humans are moving to the coastal zone. For the Department of Interior, these concerns are especially acute at National Seashores and National Wildlife Refuges, where more than 80 species of migratory waterbirds (waterfowl, shorebirds, colonial nesting species) are concentrated along the Atlantic Flyway. Some publications from research on the Atlantic and Gulf coasts suggest that for some estuaries, marsh surfaces may not be able to "keep the pace" with sea level rise; however there is a paucity of reliable simultaneous field measurements of marsh accretion and subsidence rates, coupled with tide gauge data. Therefore, we propose a 5-year study to be conducted by cooperators from two USGS Centers (Patuxent and NWRC), the National Park Service, the Fish and Wildlife Service, and the University of Virginia (VCR LTER project) that will: (1) establish monitoring stations at four key estuaries from Cape Cod to Virginia, concentrating on Interior lands. We will use tide gauges at several locations in each estuarine site and establish Sedimentation Erosion Tables

(SETs) at selected lagoonal marshes and record short term changes in accretion/subsidence quarterly; longer term data will be collected using radiodating of cores (2) research existing maps, imagery, and tide records for these coastal sites to determine the degree of qualitative and quantitative changes in wetlands since the early 1900s; for the same locations, we will attempt to reconstruct historic records of migratory bird species presence, abundance, and distribution; (3) conduct inventories (at both small- and mesoscale) of waterbird species distributions using feeding, roosting, and nesting habitats during all 4 seasons for two years at each estuarine site using ground and aerial methods; (4) develop a GIS for the physical and biological parameters measured for each study site to allow a topographic model to be developed that can be used to predict how various sea level rise scenarios may affect lagoonal marsh surfaces and migratory bird habitats.

The results from the work will allow us to develop a vulnerability list of migratory waterbirds sensitive to wetland habitat alteration, will permit qualitative assessments to be made as to the relative risk of each species/guild to sea level rise versus other limiting factors (e.g. disturbance), will help determine the importance of spatial scale (within marsh, within estuary, among estuaries) and temporal scale (season, year, decadal and longer) in partitioning the variance for both physical and biological parameters, and, using predictive models, will indicate which areas seem prone to wetland loss or change (and how they will change) and where management activities may need to be considered or altered.

The information will be synthesized into research and management reports, will be available through the NBII and the LTER (NSF's Long Term Ecological Research program) database network, and will be used to develop management plans with coastal resource managers where coastal wetlands seem to be particularly vulnerable. The information is directly relevant to all four of the 5-year USGCRP goals and objectives, supports similar activities either planned or underway at coastal Parks and Refuges, serves the objectives of the local and national LTER program, and those of other federal (EPA, NOAA, NASA), state, and non-governmental (The Nature Conservancy) organizations.

Project Title: Monitoring and Modeling Global Change Effects on Submerged Aquatic Vegetation of Intermediate Salinities Along the Gulf of Mexico Coast.

BRD Principal Contact: Jacoby Carter, Ph.D.
USGS National Wetlands Research Center
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Lafayette, LA 70506
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Duration Of Project: 5 Years

Annual Funding Request From GC Program: \$ Y1: 250.75K; Y2: 231.65K;
Y3 228.85K; Y4:227.6K; Y5: 207.75K

Total funding requested from GC program: \$ 1,256.6K

Biogeographic Region: #2 Coastal Areas

Thematic Area: #3 Modeling (vegetation, ecosystems, spatial/temporal scaling)

Key Words: Estuaries, Intermediate marsh, Invasive Species, Hydrology, Gulf of Mexico, Sea level rise, Spatio-temporal Markov chain modeling, Submerged aquatic vegetation, SAV, Water quality.

Abstract: Humans are causing dramatic changes in the world's ecosystems at scales ranging from global to local. At the global scale the combustion of fossil fuels has increased carbon dioxide (CO₂) 25% since the start of the industrial revolution. Models and evidence on changes in climatic patterns indicated that CO₂ and other anthropogenic gases are causing a warming of the Earth's atmosphere and associated changes in the planets climatic patterns.

At more local and regional scales, humans have dramatically altered nutrient regimes, hydrology, and species compositions of ecosystems. The Department of the Interior (DOI) through the National Wildlife Refuge System, National Parks and Historic Preserves manages large and extensive areas of estuary habitat along the northern Gulf of Mexico. The U.S. Fish and Wildlife Service alone manages well over one million acres of lands along the gulf coast containing significant amounts of wetlands and estuary waters. DOI land management agencies are concerned on how global change will affect resources on national parks and refuges. This mandate requires foremost that the DOI agencies be able to predict the effects of such changes on important habitats.

Submerged aquatic vegetation (SAV) provides valuable food and shelter in shallow freshwater, brackish, and marine waters of the southeastern United States for a variety of waterfowl and commercially and recreationally important fisheries. Root and rhizome systems bind and stabilize near shore sediments, and filtering and retention mechanisms within SAV beds baffle currents and ameliorate water quality. While native SAV play an important role in estuarine communities, invasive exotic SAV species can play a harmful role ecologically, and often become nuisance species to navigation as well.

Changes in SAV communities thus have profound implications for local and regional biota, shoreline geomorphology, and biogeochemical cycles. The productivity, distribution, and extent of SAV are extremely susceptible to the direct and indirect effects of global change processes. However, data to predict the direction and magnitude of potential changes or the ultimate effects on fish and wildlife populations are lacking. The purpose of the research outlined here is to understand the processes that affect the distributions and community dynamics of estuarine SAV at salinities intermediate between fresh (<0.5 ppt) and marine (>30 ppt) as opposed to seagrasses that

occur along or coast in saline and hypersaline conditions. (salinities 30.0 ppt and above).

The proposed 5-year project will answer the following questions:

What is the current distribution and health of SAV along the gulf coast?

What are the tolerance ranges of SAV?

What are the current distributions of exotics?

How do the distributions of SAV respond to changes in the environment?

How can we determine when a particular SAV species is under stress?

How do the SAV community respond to changes in environment?

How do the SAV community respond to storm events?

What are the natural successional changes that occur in the SAV community?

Our overall research strategy will be to perform a gradient analysis of SAV distributions along the gulf coast using salinity as our major gradient. In addition to examining salinity we will also document hydrology, nutrient, light, and other factors. Specifically we will:

1. Survey the distribution of estuarine SAV distributions along the gulf coast in key watersheds with a special emphasis on invasive alien species. This study will be used to assess the species compositions, ranges, and broad tolerances of SAV communities in gulf coast estuaries. Second we will use the survey to assess the extent to which alien species have become established in estuarine SAV communities. Third, this survey will be used to establish sites where some of our intensive monitoring efforts will be carried out.
2. Monitor selected transects the inter and intra-annual changes in SAV distribution. This study, in cooperation with others currently conducting SAV monitoring, will be used to develop models of SAV community response to changes in salinity, hydrology, nutrients loading, and other important environmental variables and to assess the natural variability of SAV communities.
3. Develop technologies that can be used to assess the health of SAV communities in the field. Specifically, in a joint study with NASA, we will evaluate laser induced fluorescence (LIF) for determining SAV health status in the field.
4. Create quantitative models of SAV distribution that can be used to model probable changes in distribution in response to changes in sea level, storm events, human induced changes in hydrology and nutrient regimes. Data collected in the above mentioned studies will be used to create quantitative models of SAV distributions. Analysis of species distributions will be made at both the individual and community level with special attention paid to invasive species. A spatio-temporal Markov chain simulation model will be created to predict changes in SAV communities in response to global and regional changes.

Project Summary

Project Title: Effects of Global Climate Change on Great Lakes Wetlands

BRD Principal Contact: Dr. Douglas A. Wilcox

Affiliation: USGS-Great Lakes Science Center

Address: 1451 Green Rd., Ann Arbor, MI 48105

Telephone/fax number: 734/214-7256 734/994-8780 FAX

Email: douglas_wilcox@usgs.gov

Duration of project: 5 years (FY99-FY03)

Annual funding requested from GC program: varies by year (average \$180K first 3 years)

Total funding requested from GC program: \$ 615,081

Biogeographic Feature/ Region(s)	Thematic Area(s)
Coastal areas (primary)	Coastal dynamics (primary)
Inland wetlands	Watershed response, hydrology
	Disturbance
	Terrestrial and aquatic plant habitat
	Modeling
	Invasive alien species

Key words: coastal wetlands, global climate change, Great Lakes, wetland plant communities, coastal processes, sedimentology, paleoecology, plant ecology, hydrology, wetland management

Abstract: Wetland and coastal areas of the Nation have been severely impacted by the past actions of humans. These resources are widely recognized as important habitats for many plant and animal species, and major federal programs have been directed toward their conservation and restoration. A more subtle impact will likely affect wetlands of coastal areas as a result of changes in surface- and ground-water levels owing to changes in global climate. Research is needed to determine the sensitivity of coastal wetlands to these potential impacts. This knowledge should be used to develop predictive capabilities and management strategies for conserving and restoring wetland resources.

This proposal focuses on the identified research needs for wetlands of the coastal zone of the Great Lakes, which are highly responsive to hydrologic changes. It extends previous work relating to lakes Michigan/Huron to wetlands of Lake Superior, where the hydrologic changes may differ. The objectives are to 1) quantify long-term water-level changes that occurred in Lake Superior during past climatic changes for use as a proxy for climate change; 2) determine site hydrology and hydrologic changes related to climate change; 3) determine vegetational response and sensitivity to

Project Summary

Project Title: Integrating the effects of land use and global climate change on hydrology and vegetation of Northern Great Plains wetlands.

BRD Principal Contact: Dr. Glenn R. Guntenspergen
Patuxent Wildlife Research Center
11510 American Holly Drive
Laurel, MD
301-497-5523
301-497-4497 (Fax)
Glenn_Guntenspergen@usgs.gov

Duration of Project: 5 Years

Annual funding requested from GC program: 180K, 180K, 180K, 180K, 180K

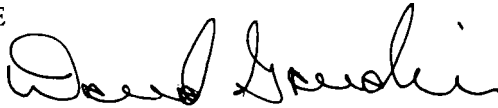
Total funding requested from GC Program: 900K

Biogeographic Feature/Region: INLAND WETLANDS

Thematic Area: MODELING

Key Words: modeling, wetland, hydrology, watershed, GIS, landscape

Abstract: A comprehensive assessment of the effects of global climate change on prairie wetland landscapes is proposed. A new wetland model, WETSCAPE, will be used to evaluate the vulnerability of the range of wetland types to changes in temperature and precipitation predicted by global climate change models. The primary geographic scope of the project is South and North Dakota where long-term wetland data are available from several field sites and where considerable analysis and modeling of wetland dynamics have been previously conducted. This area includes a substantial portion of the wetlands occurring in the larger Prairie Pothole Region. Earlier model simulations of surface water hydrology and vegetation indicated that a semipermanent wetland would be sensitive to climate change of the magnitude predicted by global circulation models. Significant ecological effects could result because prairie wetlands provide the single most important breeding area for waterfowl in North America and play a major role in regional hydrology, land use, and economics. This proposal will determine the causal mechanisms underlying wetland response to global change by focusing on the wetland hydrologic regime. WETSCAPE is based on a previously tested and published surface water site specific model of a semi-permanent wetland. WETSCAPE will be extended to model a complex of wetlands within a watershed, include a groundwater component, incorporate the effects of adjacent land use, and include wetlands of other permanence classes. We will evaluate the effects of changing land use and conservation practices as a means to mitigate global climate change impacts. We will also modify WETSCAPE so we can extend the results of local scale simulations to the landscape/regional scale and provide a region wide assessment of the integrated effects of global climate change and land use practices.

TO: ROGER BALLENTINE
FROM: DAVID GARDINER 
RE: SECRETARY BABBITT, WILDLIFE AND CLIMATE CHANGE

July 13, 1999

Key points to make to Secretary Babbitt are:

- White House wants to work with DOI to identify opportunities to communicate to the public the risks that climate change poses to wildlife and to their habitat, and to identify executive actions which the President and the administration can take to remedy the situation.
- The opportunity is great because the science is strong on several key fronts, especially game and non-game birds, freshwater fish, marine mammals and coral reefs, and because the Department of Interior oversees not only wildlife, but much of its habitat in National Parks and Wildlife Refuges. DOI also has many communications opportunities through its organizational network.
- Specifically, we should establish a work group between WHCCTF and DOI to develop a plan for a coordinated effort. Babbitt needs to designate someone to work with me to develop that plan by August 15. It should either be someone from his office directly or an Assistant Secretary with the clout to move key elements of the Department.

Possible ideas for consideration:

- A DOI assessment of the effects of climate change on wildlife and wildlife habitat.
- Distribution of educational materials at parks and wildlife refuges (see attachments).
- Initiatives for the FY2001 budget.
- An Executive Order on actions to protect wildlife or habitat.

CLIMATE CHANGE

AND ECOSYSTEMS

Thousands of scientists predict that the earth's climate will change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases. The heat-trapping property of such gases as carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons is undisputed. Greenhouse gases are released into the atmosphere in large quantities by motorized vehicles, utilities, factories, appliances, and landfills.

Although there is uncertainty about exactly how and when the earth's climate will respond to higher concentrations of greenhouse gases, observations indicate that detectable changes are underway. Temperatures will most likely rise by an average of 2 to 6°F over the next century, along with measurable changes in precipitation, soil moisture, and sea level. All of these changes could have adverse effects on many ecological systems, as well as on human health and the economy.

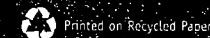


WHAT CAN YOU DO?

- Inform yourself and other. To keep up with the latest scientific developments, check out EPA's climate change website at www.epa.gov/globalwarming. Or call EPA's National Service Center for Environmental Publications (NSCEP) at 1-800-490-9198 and ask for information on climate change.
- Encourage more research. If you work for an organization that carries out related scientific studies, suggest including a climate change component to the research.
- Reduce greenhouse gases. Use a more fuel-efficient (or non-motorized) mode of transportation. Carpool. Purchase electronic devices and appliances with the ENERGY STAR label. Plant trees.



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May 1999

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EPA Climate Change and BIRDS

Change On The Wing



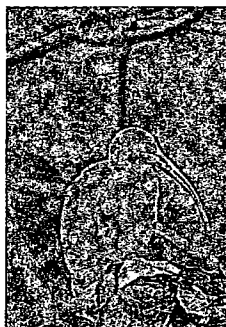
CLIMATE CHANGE

AND BIRDS

Global warming could affect the abundance and distribution of birds in the United States. Changes in climate may change nesting and feeding habitats, migratory stopover areas, and the availability of key food sources. Some impacts may be positive, making conditions more favorable for certain kinds of birds. But climate change also could lead to reduced breeding success in some species and some localities, raising the possibility of regional population declines and extinctions.

Birds require specific environmental conditions to survive and raise their young. Nesting, for example, is timed to coincide with favorable weather and food availability. If a trend toward warmer spring weather leads birds to nest earlier, their breeding success may suffer if primary food sources are not yet available when nestlings hatch.

Birds are more mobile than most other animals, and they simply can fly to a new location if a former site is no longer suitable. But global warming may make it difficult for some species to find new habitats. Plant and animal communities that provide optimal habitat today may be fundamentally altered in the future as the climate changes. A recent study suggests that ecological communities may not simply shift their range northward in response to warming, but instead may undergo complex changes as interacting species are affected in different ways by the changing climate.



CLIMATE CHANGE

AND WATERFOWL

Changes in temperature and precipitation predicted under global warming could affect the nesting habitats of ducks and other waterfowl. According to one study, global warming could cause breeding populations of ducks in the north-central United States to decline by more than half—from 5 million birds today to between 2.1 and 2.7 million by the year 2060.

Why? Warmer temperatures and more frequent droughts could cause hundreds of thousands of ponds in the prairie pothole region of the north-central U.S. to dry up. The potholes account for only 10 percent of North America's waterfowl breeding habitat, but they produce 50 to 80 percent of the continent's ducks. The pothole region also serves as an important stopover point for migrating waterfowl. Although many of the affected ducks may move north into Canada, studies suggest that climate change may affect breeding habitats in Canadian prairies and forests as well.



AND SEABIRDS

Populations of sooty shearwaters off the coast of California and Washington declined by 90 percent between 1987 and 1994, a period when sea surface temperatures increased. The decline represents a potential loss of more than 4 million birds. The warmer water triggers a reduction in upwelling, a circulatory process that brings nutrient-rich water to the ocean's surface. Over the past two decades, reduced upwelling apparently has caused a 70 percent decrease in zooplankton, a key food source for shearwaters and the small fish that the shearwaters eat.





CLIMATE CHANGE

AND ECOSYSTEMS

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WHAT CAN YOU DO?

- 1. Inform yourself and others. For more information on climate change and national parks, visit EPA's website at www.epa.gov/globalwarming and click on "impacts." Or call EPA's National Service Center for Environmental Publications (NSCEP) at 1-800-490-9198 and ask for information on climate change and how it affects wildlife, forestry, and/or sea level rise.
- 2. Encourage more research. If you work for an organization that carries out related scientific studies, suggest including a climate change component to the research.
- 3. Reduce greenhouse gases. Use a more fuel-efficient (or non-motorized) mode of transportation. Carpool. Purchase electronic devices and appliances with the ENERGY STAR® label. Plant trees.



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EPA Climate Change and PUBLIC LANDS

National Parks At Risk



CLIMATE CHANGE

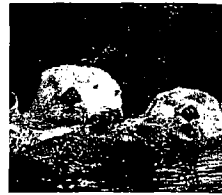
AND WILDLIFE

America's national parks were established to preserve valuable natural resources while providing environmentally diverse settings for recreation. They were intended for use by Americans of all generations to come. But these natural treasures may be at risk from global climate change if we do nothing to address the problem. Other public lands, such as national seashores, national forests, wildlife refuges, and Bureau of Land Management lands also could be affected.

Global warming could have numerous impacts on wildlife and their habitat on public lands and the waters that flow through those lands. Many inland freshwater rivers, lakes, and streams may become too warm for the fish and other aquatic species that currently inhabit them.

Climate change also may contribute to a loss of wetlands, beaches, and other habitat. As the oceans warm, the sea level rises and erosion of beaches and wetlands during storms increases. Such national park units as Padre Island, Assateague Island, Fire Island, Cape Hatteras, and Cape Cod could be affected by sea level rise.

States in coastal areas that cannot enact land use planning may find that wetlands and other coastal ecosystems cannot migrate inland as the sea rises. Critical wetlands in wildlife refuges and other public lands could be lost as a result.



CLIMATE CHANGE: PUBLIC LANDS AT RISK

Glacier National Park is located in a pristine mountainous area in northwestern Montana. The park provides habitat for an abundance of wildlife, including the densest population of grizzly bears (a threatened species) in the United States. Climate change could have a serious impact on this national treasure. The park has approximately 150 glaciers, down from an estimated 150 in 1850. The recession of Sperry Glacier illustrates the impact of recent warming temperatures. If warming trends continue, it is estimated that the park will have no glaciers by 2030. Without glaciers, stream temperatures are expected to rise. Higher water temperatures could affect aquatic ecosystems, especially trout species. Climate change also could alter the types of trees found in the park.

Alaska's pristine ecosystems are especially vulnerable to climate change since warming is projected to be greater at higher latitudes than in other parts of the world. With sufficient increases in temperature, tundra ecosystems are expected to decline significantly. Melting permafrost in Alaska's ruggedly beautiful Denali National Park could jeopardize essential habitats for caribou herds. Melting permafrost also affects freshwater wetland habitats and may lead to increased landslides and erosion. It may clog spawning rivers with silt and trigger the loss of some boreal forests.

Reductions in tundra and related ecosystems also would mean the loss of mammal and migratory waterfowl habitats. In addition, Alaska's native Coho, sockeye, and chinook salmon found in Glacier Bay, Katmai, and Wrangell-St. Elias national parks may be affected by the warming of lakes and rivers.

Saltwater already has intruded 5 miles into **Everglades National Park** from Florida Bay. Increased salinity resulting from sea level rise could damage freshwater ecosystems in the Everglades that provide important habitat for birds, fish, and other wildlife. Freshwater wetlands such as sawgrass, slough, and wet prairie, which are important foraging habitat for wading birds and other wildlife, would decrease in area. These habitat changes could increase pressures on endangered species such as the Florida panther, Key deer, American crocodile, and the Everglades mink.

Without the promise of a stable climate, the history, heritage, wilderness, and beauty preserved by America's public lands are at risk. Climate change could increase the possibility of drought and thus kill the whitebark pines, a source of edible nuts for grizzlies in Yellowstone Park. Fires and flooding also could change the composition of Yellowstone and many other of our nation's celebrated landscapes.



CLIMATE CHANGE AND ECOSYSTEMS

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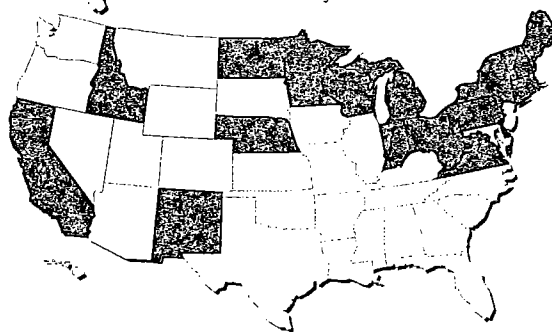
Temperatures will most likely rise by an average of 2 to 6°F over the next century, along with measurable changes in precipitation, soil moisture, and sea level. All of these changes could have adverse effects on many ecological systems, as well as on human health and the economy.



Map: U.S. Environmental Protection Agency. 1995. Ecological Impacts from Climate Change: An Economic Analysis of Freshwater Recreational Fishing. EPA 220-R-95-004. Exhibit 2-26.

POTENTIAL LOSS OF HABITAT Cold Water Fish

■ 50-100% Loss ▮ 1-49% Loss
□ Not included in analysis

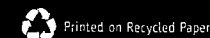


FOR MORE INFORMATION

To keep up with the latest scientific developments, check out EPA's climate change website at www.epa.gov/globalwarming/. Click on [impacts/fisheries/](#) for specific information on how climate change may affect outdoor recreation and fishing. Or call EPA's National Service Center for Environmental Publications (NSCEP) at 1-800-490-9198 and ask for information on climate change and fishing.



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May 1999

EPA Climate Change and COLD WATER FISH

Is Trout Fishing An Endangered Sport?



CLIMATE CHANGE AND COLD WATER FISH

Aquatic ecosystems will be affected by climate change. The distribution of freshwater species is likely to shift northward, with some extinctions of local species likely throughout the southern ranges of these species and expansion in their northern ranges.

Warmer freshwater temperatures and changes in the pattern of flows in spawning rivers could reduce the abundance of species like salmon, trout, and bass.

For example, an 8°F increase in mean annual air temperature is projected to eliminate more than 50 percent of the habitat of brook trout in the southern Appalachian Mountains.

In addition, projected changes in water temperatures, salinity, and currents could affect the growth, survival, reproduction, and distribution of marine fish species and their competitors and predators.

The survival, health, migration, and distribution of many North American marine mammals and sea turtles also are expected to be affected by projected changes in the climate through impacts on their food supply, sea-ice meltdowns, and breeding or nesting habitats.



CLIMATE CHANGE: WHAT MIGHT WE LOSE?

The loss of fishing opportunities due to climate-induced changes in fisheries could be severe in some parts of the country, especially at the southern boundaries of the habitat ranges of cool- and cold-water species.

Although gains in warm-water fishing opportunities may offset overall losses in cold-water fishing opportunities, the potential effects on specific localized regions are cause for concern.

For example, cold water fish habitats could be lost entirely in such states as Maine, Massachusetts, Connecticut, Ohio, and Nebraska. Presently, more than 750,000 people fish for trout in those states each year. How many people would or could switch to a warm water species is uncertain.

What can you do? Help reduce greenhouse gases. Use a more fuel-efficient (or non-motorized!) mode of transportation. Carpool. Purchase electronic devices and appliances with the ENERGY STAR® label. Plant trees. Educate yourself and others about climate impacts. Share research and encourage more of it.





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Technology Making a Difference Where Americans Live

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PATH

PARTNERSHIP FOR ADVANCING TECHNOLOGY IN HOUSING



President Bill Clinton officially launched the Partnership for Advancing Technology in Housing (PATH) May 4, 1998 in Los Angeles, California during ground-breaking ceremonies for 186 energy-efficient, moderately priced homes in the San Fernando Valley.

The President described PATH as “the most ambitious effort ever to help private home builders and home owners make cost-effective, energy saving decisions that will pay big dividends throughout the 21st century.” He urged leaders from the home building, product manufacturing, insurance and financial industries and representatives from federal agencies dealing with housing issues to work together to spur housing design and construction innovations.

Today hundreds of industry and government partners have joined the effort to speed up the creation and widespread use of new types of construction and housing technologies and products to make American homes stronger, safer and more durable; more energy efficient, environmentally friendly; easier to maintain; less expensive to operate; and more comfortable to live in.

PATH provides builders and consumers with the latest information on innovative building materials, products and systems. Among the new housing technologies and products that PATH partners are testing are: light-weight concrete blocks that reduce construction costs and increase energy efficiency; steel framing for houses; windows that offer as much insulation as walls; photovoltaic roof shingles that turn the sun’s rays into electricity; cold weather paints that extend a contractor’s painting season, as well as dry quicker to resist moisture, frosting and blistering; state-of-the-art wiring systems that support home office, entertainment and security needs; and geothermal heat pumps that use the Earth itself as a cost-effective heating and cooling energy source.

PATH is on the lookout for builders that want hands-on experience with new housing technologies, products and systems. It offers technical assistance to individual builders and remodelers who are willing to evaluate specific promising technologies in their housing. Manufacturers participating in the PATH initiative can ask for feedback on changes needed to improve their products’ ability to meet PATH goals.

PATH also promotes new housing technologies through “pilot projects” which are demonstration programs with builders across the country. Currently PATH is working with builders and city officials in Denver, Los Angeles, Pittsburgh and Tucson and it is looking for additional sites.

In an effort to stimulate the development of the “next generation” of American housing technology, PATH encourages cooperative research among partners – in private industry, research universities and national laboratories. In addition, it will sponsor a “Conference on the Future of the House” in 1999 which the housing community could use to help set its national research and development agenda.

PATH partners also work to remove institutional and regulatory barriers to innovation in the housing industry. Among the barriers that the partners tackle are the lack of a clear national system for the evaluation of new products and systems, outdated building codes, inefficient processes for securing building approvals as well as inadequate training for the new technologies.

By 2010 Congress expects PATH to: (1) reduce the monthly cost of new housing by 20 percent or more; (2) cut the environmental impact and energy use of new housing by 50 percent or more and reduce energy use in at least 15 million existing homes by 30 percent or more; (3) improve durability and reduce maintenance costs by 50 percent and; (4) reduce by at least 10 percent the risk of loss of life, injury and property destruction from natural hazards and decrease by at least 20 percent residential construction work illnesses and injuries.

When PATH meets those goals new homeowners can expect to save at least \$750 each year on energy bills, or \$23,000 over the average 30 year mortgage. Less energy consumption also means reduced carbon emissions – 24 million tons a year, equivalent to the amount produced today by 20 million cars.

PATH participating organizations direct the initiative through their commitment of time, resources and leadership. PATH partners agree to make good faith efforts to offer housing products that meet PATH goals in large markets by 2010; participate in the joint management of the partnership; share non-proprietary information about the costs, benefits and other characteristics of building innovations with the partnership; and work with appropriate federal and state agencies to develop and implement tests of innovative products and systems.

Public sector partners include the U.S. Departments of Agriculture, Commerce, Defense, Energy, Housing and Urban Development, Labor and Transportation, the Environmental Protection Agency, the Federal Emergency Management Agency, the National Science Foundation, and the White House Office of Science and Technology Policy.

WHAT IS PATH?

PATH is a public/private partnership created to develop, demonstrate, and deploy the technologies that will bring about the next generation of American housing and work to improve the existing housing stock.

The goal of the Partnership is to accelerate the creation and widespread use of advanced technologies in order to improve the quality, durability, environmental performance, energy efficiency, and affordability of tomorrow's homes.

PATH GOALS

By 2010 these technologies will make it possible to:

- ♦ Reduce the monthly cost of new housing by 20 percent.
- ♦ Cut the environmental impact and energy use of *new housing* by 50 percent or more and reduce energy use in at least 15 million *existing homes* by 30 percent or more.
- ♦ Improve durability and reduce maintenance costs by 50 percent.
- ♦ Reduce by at least 10 percent the risk of loss of life, injury, and property destruction from natural hazards and reduce by at least 20 percent residential construction work illness and injuries.

PATH PARTNERS

PATH was initiated by Congress and the White House with the following Federal Agency partners: the Department of Housing and Urban Development, the Department of Energy, the Department of Commerce, the Environmental Protection Agency, the National Science Foundation, the Department of Agriculture, the Department of Labor, the Department of Transportation, and the Federal Emergency Management Agency. Additional federal, state, and local government partners are expected to join PATH in the coming months.

PATH is now seeking leaders in the private sector to make the Partnership complete.

BENEFITS TO PRIVATE PARTNERS

- ♦ *Improved access to advanced housing technologies;*
- ♦ *An accelerated approval process;*
- ♦ *Risk reduction;*
- ♦ *Volume business opportunities;*
- ♦ *Marketing support;*
- ♦ *Cooperative R&D underwriting;*
- ♦ *New product development opportunities;*
- ♦ *Assistance in demonstrating new technologies;*
- ♦ *Volume sales; and*
- ♦ *Accelerated market penetration for new technologies.*

To find out more about PATH, please contact:

John Blair, PATH Communications

Phone: 202-708-4277 (x106)

Fax: 202-708-4250

Email: pathnet@pathnet.org

Online: www.pathnet.org

WHAT ARE THE TECHNOLOGIES?

To accelerate the adoption of promising technologies, PATH will identify, evaluate, and place in a database advanced and emerging technologies. Builders and remodelers interested in trying and evaluating innovative products and systems will be teamed with participating producers. Technical assistance will be available to capture real-world data on the technologies so that others in the industry can benefit from the lessons learned.

PATH EVALUATION CRITERIA

PATH criteria will evaluate materials, technologies and processes according to their impact on:

- ♦ *Annual cost of homeownership and construction cost;*
- ♦ *Durability and maintainability;*
- ♦ *Functionality and quality;*
- ♦ *Energy efficiency;*
- ♦ *Construction waste;*
- ♦ *Use of recycled, engineered, or alternative materials;*
- ♦ *Carbon emissions levels through energy generation/consumption;*
- ♦ *Indoor air quality;*
- ♦ *Jobsite safety;*
- ♦ *Losses due to natural disasters; and*
- ♦ *Market penetration.*

PATH TECHNOLOGIES INCLUDE:

- ♦ *Aerosol Duct Sealing*
- ♦ *Air-To-Air Heat Exchangers*
- ♦ *Autoclaved Aerated Concrete*
- ♦ *Category 5 Wiring*
- ♦ *Composite Panel Housing Systems*
- ♦ *Drain Water Heat Recovery*
- ♦ *Fiber Optic Switches*
- ♦ *Flexible Gas Piping*
- ♦ *Fuel Cells*
- ♦ *Geothermal Heat Pumps*
- ♦ *Hybrid Manufactured Housing Systems*
- ♦ *Horizontal Axis Washing Machines*
- ♦ *Insulated Concrete Forms*
- ♦ *Laminar Flow Faucets*
- ♦ *Low-e Windows with Recycled Wood Composite Frames*
- ♦ *Mini Duct Systems*
- ♦ *Photovoltaic Shingles or Roofing Panels*
- ♦ *Recycled Oak Flooring*
- ♦ *Steel Frame Wall Systems*
- ♦ *Super High Efficiency Air Conditioners with no CFCs*
- ♦ *Thermochromic Windows*
- ♦ *Tubular Skylights*

For more information, on PATH technologies, contact: NAHB Research Center

Phone: 800-638-8556; Fax: 301-249-0305

Email: Lbowles@nahbrc.org

Online: www.nahbrc.org

HOW ARE THE TECHNOLOGIES COMMUNICATED?

To accelerate the widespread use of advanced technologies in the next generation of American homes, the government has formed a partnership with the home building industry. The PATH Partnership will take advantage of a variety of communications approaches for providing information on emerging technologies to the building industry. The HOMEBASE Services Program of the NAHB Research Center has been chosen to assist the PATH Program in communications outreach. The program includes the Internet, CD-ROMs, a newsletter, and a telephone hotline where technical experts provide timely answers to callers' most difficult questions.

CHECK US OUT ON THE WEB

Useful PATH Program information is provided at the PATH website at **www.pathnet.org**. It provides linkages to other sources of information and websites of PATH Partners. It also provides a linkage to a Directory of Emerging Technologies that is located on the HOMEBASE website at **www.nahbrc.org/homebase**.

GIVE US A CALL: 800-898-2842

PATH will utilize the HOMEBASE HOTLINE, a toll-free service that is staffed by engineers and other technical professionals who help find solutions to technical questions. Since the debut of the Hotline in 1996, thousands of inquiries have been addressed. Over 8,000 calls were answered in the last year alone. Internet users can "Ask an Expert" and pose questions of the HOMEBASE SERVICES technical staff at **www.nahbrc.org/homebase**.

READ ALL ABOUT IT: HOMEBASE NEWS

A quarterly newsletter called *HOMEBASE NEWS* keeps subscribers abreast of issues related to building technology and materials. Our most recent edition (Winter 1999) features the PATH Program and was distributed to nearly 70,000 builders and remodelers through state and local home builder associations nationwide.

JUST LOAD, POINT, AND CLICK

A *Catalog of Building Products and Services* is published on CD-ROM and the Internet. The Catalog is updated and expanded three times a year. It features useful information on building technologies and is distributed free to all incoming and current members of NAHB.

For more information on the technologies and resources available through

HOMEBASE SERVICES, visit the website at www.nahbrc.org/homebase or call the HOMEBASE HOTLINE at 800-898-2842.

I'd like to find out how to become a PATH Partner.

For Builders and Remodelers:

Tell us about one of your recent projects that features innovative products or technologies.

Would you be interested in trying some innovative building technologies in one of your pending projects? Tell us about the project.

For Product Manufacturers:

What innovative technologies have you developed that PATH could feature in its emerging technology inventory?

Tell us more about the features of the products and how they will help meet PATH goals.

☒ **Please send me more information.**

Name

Title

Company

Address

City/State/Zip

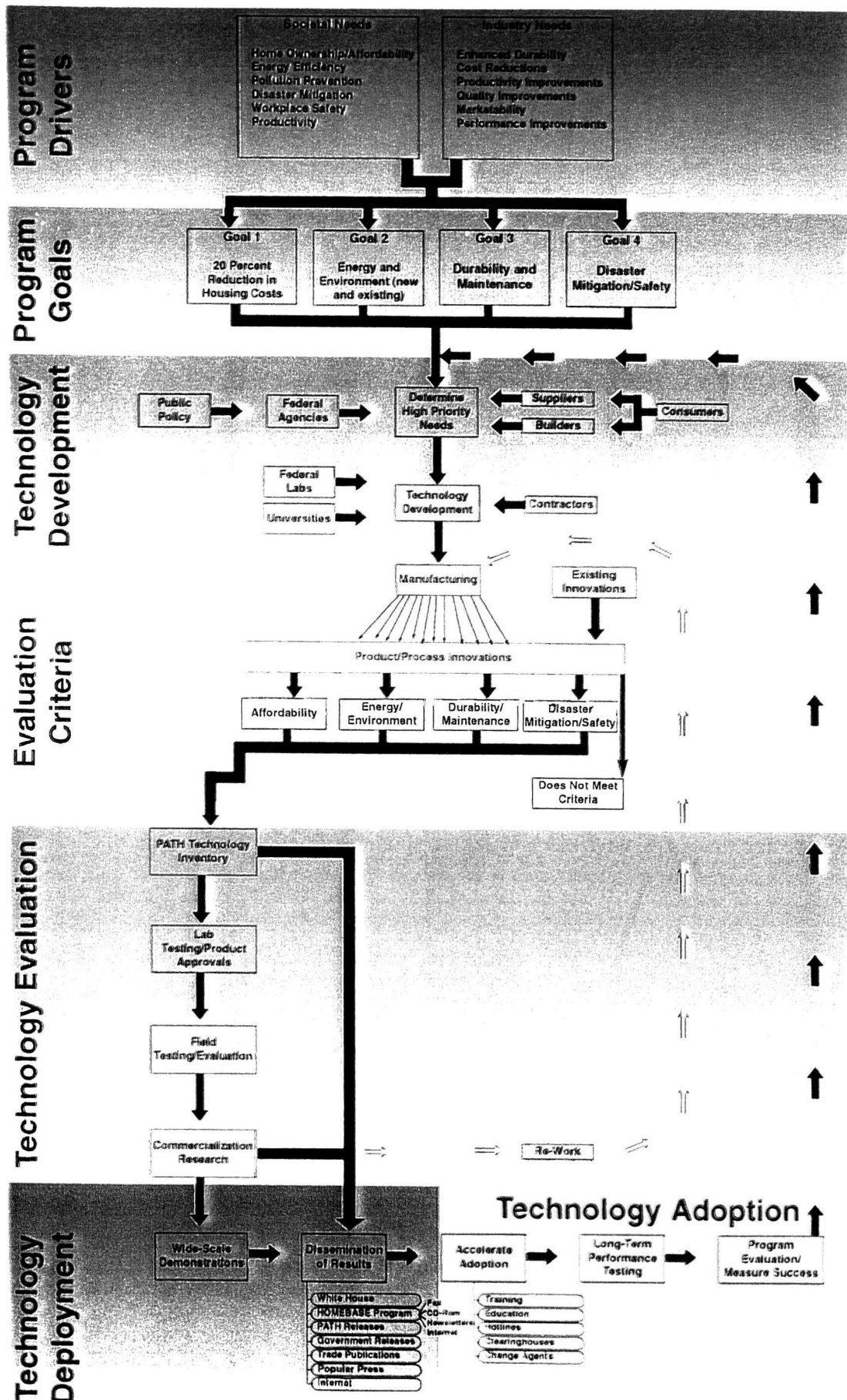
Phone #

Fax #

E-mail Address

**Please fax to (301) 249-0305
Attention: Liza Bowles**

PATH Program Plan



**Operating Plan for the Partnership for
Advancing Technology in Housing (PATH) Program
February 15, 1999**

Operating Plan for the Partnership for Advancing Technology in Housing (PATH) Program

I. Background

The Partnership for Advancing Technology in Housing (PATH) is a voluntary initiative that seeks to accelerate the creation and widespread use of advanced technologies to radically improve the quality, durability, environmental performance, energy efficiency, and affordability of our Nation's housing. It follows a 3-year, government and industry process to establish National Construction Goals for the residential construction industry. PATH program goals build on the consensus set of goals that were established through the National Construction Goals process and are documented in *Building Better Homes at Lower Costs: The Industry Implementation Plan for the Residential National Construction Goals*.

President Clinton formally launched the PATH program on May 4, 1998, at an affordable housing demonstration site in Los Angeles. Joining the President in launching the program was Donald Martin, the 1998 President of the National Association of Home Builders.

In support of this important initiative, Congress appropriated \$10 million in the U.S. Department of Housing and Urban Development (HUD) budget for FY 1999. This \$10 million, by itself, is not the entire PATH program. These funds will be used to leverage other private and public efforts, to coordinate research planning and implementation, and to disseminate technical information to the housing industry. The Conference Report requires that HUD "cooperate with other Federal agencies and the housing industry, and to engage in PATH activities that will provide research, development, testing, and engineering protocols for building materials and methods, as described in the Industry Implementation Plan of the Residential National Construction Goals." The conferees further directed HUD "to furnish the Veterans Administration (VA), HUD and Independent Agencies subcommittees with an operating plan for PATH, including specific and measurable goals, no later than December 31, 1998, and a draft evaluation report describing progress made toward meeting those goals no later than April 30, 1999." This operating plan incorporates input from HUD, the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), the U.S. Department of Commerce (DOC), the U.S. Department of Agriculture (USDA), the U.S. Department of Labor (DOL)/OSHA, the Federal Emergency Management Agency (FEMA), the U.S. Department of Transportation (DOT), and the National Science Foundation (NSF), in addition to manufacturer, builder, and remodeler input from the housing industry.

II. Management Plan

The PATH program is managed by HUD. Day-to-day management of the program is provided by a Director and his/her staff. The Director reports to the Assistant Secretary for Housing/FHA Commissioner. To accelerate the use of PATH technologies in its programs, HUD has established an intraagency working group composed of representatives from HUD's housing programs that will identify areas for cooperation. This group has been meeting monthly since November 1998.

Leadership of the overall policy direction for PATH is provided by HUD and DOE in cooperation with the PATH Interagency Council (PIC), composed of senior representatives from DOE, HUD, EPA, FEMA, DOC, and USDA. The PATH Director serves as executive secretary to PIC, which meets quarterly, beginning in November 1998. The purpose of the PIC is to provide Federal policy guidance; to monitor PATH progress, including individual agency contributions to PATH; and to identify targets of opportunity for participation by principals.

In addition to PIC, a Federal agency working group—with representatives from all the Federal agencies participating in PATH—has been established to facilitate day-to-day coordination of Federal activities pertaining to the program. The working group supports PIC in developing policy guidance for PATH, identifies individual agency contributions to PATH, establishes Federal agency technical assistance teams for specific PATH projects, and promotes PATH goals and initiatives within individual agencies. The Federal agency working group meets monthly and functions as a task force of the Construction and Building Subcommittee of the National Science and Technology Council, under the overall direction of the PATH Director. Secretariat duties for the working group are provided by the Secretariat for the Construction and Building Subcommittee.

A PATH Coordinating Council (PCC)—made up of representatives from the homebuilding, product manufacturing, insurance, and financial industries, in cooperation with PATH's Federal agency partners—provides general guidance to PATH management. The PCC has met twice and will continue to meet three times per year, with at least one of the meetings organized for and attended by senior principals from the participating organizations. The PCC's purpose is to provide private-sector input to PATH programs, to participate in PATH initiatives, and to stimulate industry to address PATH goals.

In conformance with congressional direction, HUD is developing a data collection and evaluation plan for PATH in cooperation with agency and private-sector partners. This data collection plan and evaluation criteria will provide the basis for a draft evaluation report due to Congress by April 1999.

III. Objectives and Goals

The objectives of the PATH program are to improve the quality, affordability, durability, and energy efficiency of today's new and existing homes; to strengthen the technology infrastructure of the United States; and to help create the next generation of American housing. These objectives and specific goals were developed by a residential working group convened to apply the National Construction Goals to the residential sector of the construction industry.

The residential sector working group convened a series of industry and government meetings to develop strategies that would help achieve the National Construction Goals. The group developed seven specific strategies and a set of action plans to help government and industry to achieve the national goals. This framework was used by the Administration to develop the PATH goals set forth by the President. The PATH program sets ambitious but achievable goals to be met by the year 2010.

During the next decade, the partnership aims to develop approaches, innovative housing components, designs, and production methods that will reduce by 50 percent the time needed to

move quality technologies to market. These technologies will make it possible to produce housing that is affordable and attractive. At the same time, these new technologies will, by the year 2010:

- Reduce the monthly cost of new housing by 20 percent or more.
- Cut the environmental impact and energy use of *new housing* by 50 percent or more and reduce energy use in at least 15 million *existing homes* by 30 percent or more.
- Improve durability and reduce maintenance costs by 50 percent.
- Reduce by at least 10 percent the risk of loss of life, injury, and property destruction from natural hazards and reduce by at least 20 percent residential construction work illnesses and injuries.

A baseline document was prepared for the PATH program that pulls together readily available data to help measure progress toward meeting these goals. This report, *PATH Baseline Data and Information Resource Guide*, is enclosed. Because much of the data is collected on a regional basis, we can tailor solutions that will match regional variations in climate and customs.

IV. Action Plans

Action plans for achieving these program goals are described below. The roles of potential PATH partners for each goal are also presented.

1. Reduce Cost of New Housing

Goal: By the year 2010, reduce the monthly cost of new housing by 20 percent or more.

Approach: Develop new technology and accelerate the use of existing technology that can reduce the planning, design, construction, operation, maintenance, repair, and replacement costs of housing, including technologies that can reduce costs through reductions in cycle time and technologies that increase quality and durability.

Action Items:

INITIAL

Technology Development and Evaluation

1. Challenge PATH partners and the housing industry to invest in coordinated research, development, and demonstration activities that will help to achieve PATH goals.
2. Put in place a process for recognizing significant advancements in technology, land use, and construction practices that will help achieve PATH goals and promote their adoption by the building industry.
3. Track and evaluate emerging technologies and alternative materials for their potential to reduce housing costs (first costs and life-cycle costs).

4. Develop a model for identifying and testing new technologies that, if accepted into practice, would help achieve PATH goals.
5. Work with manufacturers to test models for new technology prototypes.
6. Sponsor fundamental research through NSF at academic institutions that could lead to breakthrough technology applications relating to PATH goals.
7. Work with HUD program offices (Public Housing, Indian Housing, Community Planning and Development) to identify suitable HUD-assisted projects that can be PATH demonstrations and pilots, with near-term technical assistance to incorporate PATH technologies in new and rehabilitated housing on the Pine Ridge Reservation in South Dakota, various Colonias sites, and disaster mitigation in Puerto Rico after Hurricane Georges.
8. Conduct demonstrations of technologies that fit PATH goals relating to housing affordability.
9. Coordinate activities with DOE's Building America program (see Goal 2).
10. Provide technical assistance to identified PATH national pilot projects.

Federal Program Outreach/Regulatory Streamlining

11. Work with program offices to modify forthcoming NOFAs (Notices of Fund Availability) to make use of appropriate PATH technologies as a factor for selection.
12. Work with HUD program offices to review regulations and guidance material to encourage use of new technologies.
13. Develop a strategy and implement a targeted dissemination program to educate housing authorities, nonprofits, and other HUD grantees about the availability and proper application of appropriate PATH technologies.
14. Identify codes and standards and legal and institutional issues that will either help to accelerate adoption, or are impediments to adoption. More specifically, explore with the housing industry new or improved insurance and other programs that can reduce the fear of risk and the resulting liability that may result from the use of innovative building products.
15. Coordinate activities with EPA's ENERGY STAR® Homes program (see Goal 2).
16. Conduct an aggressive program of informational outreach to communicate program results and direction to the housing industry and the general public.

Testing and Evaluation

17. Conduct laboratory and short-term field testing and communicate the results and recommendations for product improvements back to manufacturers.
18. Deliver technical assistance to companies in making necessary improvements to their products so that they can gain code and market acceptance with their innovative products and systems.
19. Conduct evaluations and document the costs and performance attributes of PATH technologies that have been incorporated into recently completed demonstration projects.

ONGOING ACTIVITIES

Technology Needs Assessment/Form PATH Partnerships

1. Develop a "technology roadmap" to identify technological advances and a strategy to meet PATH goals, and form partnerships between government and industry to focus on high-priority industry needs.

2. Track and evaluate emerging housing and land-use technologies and alternative materials for their potential to reduce housing costs (first costs and life-cycle costs).
3. Challenge private-sector and public-sector partners to invest in the necessary R&D to create breakthroughs in technology that can be brought into practice by 2010.
4. Develop partnerships with manufacturers and builders to develop and test new technologies that can help meet PATH goals.

Field Testing/Demonstrations

5. Conduct extensive field testing and evaluations with builders, remodelers, and product manufacturers on the installation and field performance of next-generation innovative products in meeting PATH goals.
6. Develop wide-ranging product and systems demonstrations throughout the U.S. in conjunction with local communities to evaluate methods for streamlining acceptance of advanced technologies and communicate the results to the industry and the general public.

Industry Outreach/Education

7. Conduct an aggressive program of building industry outreach through HOMEBASE, the USDA Cooperative Extension Service, and other vehicles to communicate results of the program to potential users.
8. Develop and evaluate methods for accelerating adoption of new housing technologies by builders and consumers.
9. Develop programs of education and training to show builders and remodelers how to incorporate the high-priority PATH technologies into practice.

Program Resources:

Role:

HUD

Identify high priority technologies
Field testing/evaluations
Wide-ranging demonstrations
Dissemination of results

USDA

Technology identification/development
Needs assessment
Technology transfer

DOE

Technology development
Technical evaluation and testing

EPA

ENERGY STAR[®] Homes program and labeling

DOC/NIST

Program evaluations
Evaluation criteria
Test methods
Technical analysis
Benchmarking environmental performance
Streamline building regulatory process

Product manufacturers

Product development
Prototype testing/evaluation

Builders/Remodelers

Identify technology needs
Develop innovative practices
Installation assessments
Market assessments

Evaluation:

Baseline housing cost information is contained in the PATH report entitled *Baseline Data and Information Resource Guide*, published on May 1, 1998, and available through the U.S. Department of Housing and Urban Development. Performance measures to assess the progress toward achieving PATH goals related to monthly housing costs will use, among others, the data sources contained in this report.

2. Energy and Environmental Impact

Goal: By the year 2010, cut the environmental impact and energy use of *new housing* by 50 percent or more and reduce energy use in at least 15 million *existing homes* by 30 percent or more.

Approach: Focus on the development and evaluation of advanced, energy-efficient building technologies and approaches that can improve the energy performance and reduce the environmental impact of new and existing housing without negatively affecting housing affordability, durability, or indoor air quality.

Action Items:

INITIAL

Baseline Assessment/Technology Evaluation

1. Develop an environmental baseline that will enable the measurement of progress toward achieving PATH environmental goals.
2. Develop approaches for incorporating energy efficiency improvements into the remodeling of *existing* residences.
3. Evaluate emerging technologies for their potential to reduce home energy use without raising costs or negatively affecting durability or indoor air quality.

Technical Assistance/Demonstrations and Pilots

4. Deliver technical assistance to companies to make necessary improvements to their products in order to gain code and market acceptance with their innovative products and systems.
5. Deliver technical assistance to builders and home systems providers on energy-efficient construction practices that do not diminish indoor air quality.

6. Coordinate activities with the EPA ENERGY STAR® Homes program and DOE's Building America program.
7. Provide technical assistance to identified PATH pilot projects.
8. Conduct evaluations and document the costs and performance attributes of PATH technologies that have been incorporated into recently completed housing projects with Federal sponsorship.
9. Evaluate and delineate the appropriate role of deconstruction as an approach to reducing waste and recycling building materials.
10. Work on the Green Builder Model program and the Green Builder Conference scheduled for April 1999.

ONGOING

Needs Assessment/Form PATH Partnerships

1. Develop a "technology roadmap" to identify technological advances and a strategy to meet PATH energy and environmental goals, and form partnerships between Government and industry to focus on high-priority industry needs.
2. Challenge private-sector and public-sector partners to invest in the necessary R&D over the longer term to create breakthroughs in technology that can be brought into practice by 2010.

Field Testing and Evaluation

3. Conduct extensive field testing and evaluations with builders, remodelers, and product manufacturers on the installation and field performance of next generation innovative products in meeting PATH energy and environmental goals.
4. Institute a comprehensive program to achieve the targets for existing buildings.
5. Develop appropriate test methods for the evaluation of indoor emissions used in residential construction.

Conduct Demonstrations and Pilots

5. Develop wide-ranging product and systems demonstrations throughout the U.S., incorporating high-priority PATH technologies. Evaluate methods for streamlining acceptance of advanced technologies and communicate the results to the industry and the general public.
6. Provide technical assistance to identified PATH pilot projects.
7. Assess and compare emissions from materials used to construct residences.

Industry Outreach and Education

7. Perform regular evaluations of PATH program success in achieving goals.
8. Conduct an aggressive program of building industry outreach through HOMEBASE, the USDA Cooperative Extension Service, and other vehicles to communicate results of the program to potential users.
9. Develop education and training programs to show builders and remodelers how to incorporate the high-priority PATH technologies into practice.

Program Resources:***Role:***

HUD	Identify high-priority technologies Field testing/evaluations Wide-ranging demonstrations Dissemination of results
DOE	Technology identification/development Field testing/evaluations Wide-ranging demonstrations Evaluations relating to energy use Dissemination of results
EPA	ENERGY STAR® Homes program Builder/remodeler/finance outreach Develop sales and marketing tools Develop environmental baseline Develop Model Green Builder programs Field testing/evaluations (climate change/IAQ) Construction waste/deconstruction programs Evaluations relating to environmental performance Research and demonstration efforts on indoor air quality
USDA	Technology development (VOC reduction) Technology transfer
DOC/NIST	Test method development Technical analysis Performance standards Benchmarking environmental performance Cybernetic building system measurements Advanced insulation measurement test methods
Product manufacturers	Product development Prototype testing/evaluation
Builders/Remodelers	Identify technology needs Develop innovative practices Installation assessments Market assessments

Evaluation:

In addition to the baseline information contained in *Baseline Data and Information Resource Guide*, published on May 1, 1998, and available through the U.S. Department of Housing and Urban Development, DOE's Energy Information Administration gathers extensive data on energy usage in residential housing. Performance measures to assess the progress toward achieving PATH goals related to energy costs will use, among others, the data sources contained

in this report. The *Baseline* report points out the lack of good current data on the environmental performance of housing, which will make it difficult to quantify improvements in the environmental performance of housing.

3. Improve Durability and Reduce Maintenance Costs

Goal: By the year 2010, improve durability and reduce maintenance costs by 50 percent.

Approach: Focus on developing an understanding of how building products will perform over time—by themselves and when they are integrated into building systems—and how more durable products can reduce maintenance requirements for homeowners.

Action Items:

INITIAL

Needs Assessment/Technology Evaluation

1. Analyze problems and issues that have been raised by builders and remodelers, placing calls to the HOMEBASE Hotline to determine high priority areas of need.
2. Conduct a statistical survey of the existing housing stock to identify the magnitude and occurrence rates of various performance problems in existing housing.
3. Evaluate alternative materials that can improve the durability of building systems while reducing homeowner maintenance requirements.
4. Evaluate emerging technologies for their potential to prolong the life of residential structures.
5. Conduct evaluations and document the costs and performance attributes of PATH technologies that have been incorporated into recently completed demonstration projects.

Field Testing and Analysis

6. Conduct research to improve performance of exterior building products.
7. Conduct extensive field testing and evaluations with builders, remodelers, and product manufacturers on the installation and field performance of innovative products and construction practices that contribute to enhanced durability and reduced maintenance and repair.
8. Based on the results of previous evaluations, identify a set of high-priority technologies that, if accepted into practice, would help achieve PATH durability goals.
9. Develop wide-ranging product and systems demonstrations throughout the U.S. incorporating high-priority PATH technologies. Evaluate methods for streamlining acceptance of advanced technologies and communicate the results to the industry and the general public.

ONGOING

Performance Assessment/Technology Development

1. Develop methods to determine long-term performance of products utilizing short-term test procedures and standardize them through the ANSI and ASTM processes. Test these procedures on innovative products promising durability and maintenance improvements.

2. Develop a “ technology roadmap” that can identify technological advances and strategies needed to meet PATH durability goals and form partnerships between Government and industry to focus on high-priority industry needs.
3. Challenge private-sector and public-sector partners to invest in the necessary R&D to create breakthroughs in technology that can be brought into practice.

Field Testing/Demonstrations and Pilots

4. Conduct extensive field testing and evaluations with builders, remodelers, and product and home systems manufacturers on the installation and field performance of next-generation innovative products in meeting PATH durability goals.
5. Develop wide-ranging product and systems demonstrations throughout the U.S. in conjunction with local communities to evaluate methods for streamlining acceptance of advanced technologies and communicate the results to the industry and the general public.

Industry Outreach and Education

6. Conduct an aggressive program of building industry outreach through HOMEBASE and other vehicles to communicate results of the program to potential users.
7. Develop education and training programs to show builders and remodelers how to incorporate the high-priority PATH technologies into practice.
8. Perform regular evaluations of PATH program success in achieving goals.

<i>Program Resources:</i>	<i>Role:</i>
USDA/Forest Products Lab	Durability studies
DOC/NIST	Methods for predicting long-term performance Laboratory testing/evaluation Program evaluation Durability research program Cybernetic building system measurements Structural performance prediction
DOE/NIST	Develop test regime for new building products Accelerate market adoption of best technologies
Product manufacturers	Product development Prototype testing/evaluation
Builders/Remodelers	Identify technology needs Develop innovative practices Installation assessments Market assessments

Evaluation:

Data on maintenance and repair costs in residential housing is contained in the PATH report entitled *Baseline Data and Information Resource Guide*, published on May 1, 1998, and available through the U.S. Department of Housing and Urban Development. The data does not give a good picture of the occurrence rates of various performance problems in existing housing. Because a better baseline is needed to measure progress toward achieving PATH goals related to maintenance and repair, the Department of Commerce is developing testing and evaluation protocols for durability.

4. Reduce Risk from Natural Hazards and Construction Work Illness and Injury

Goal: By the year 2010, reduce by at least 10 percent the risk of loss of life, injury, and property destruction from natural hazards and reduce by at least 20 percent residential construction work illnesses and injuries.

Approach: Focus on developing and demonstrating products, systems, and techniques that can minimize the risk of fire in residential housing and cost-effectively withstand the forces of natural disasters (hurricanes, floods, and earthquakes). Develop training and outreach programs that will enable the residential construction industry to implement methods for reducing workplace illness and injury.

Action Items:

INITIAL

Disaster Mitigation

1. Develop an approach for systematically improving the quality of housing that is better able to resist the forces of natural hazards.
2. Evaluate alternative materials that can improve the ability of building systems to resist fire and natural disasters.
3. Evaluate emerging technologies for their potential to meet PATH goals of housing affordability and disaster mitigation.
4. Conduct demonstrations of disaster mitigation approaches that meet PATH goals in disaster-prone communities.
5. Deliver technical assistance on disaster relief in Latin American countries that were hit by Hurricanes Mitch and Georges.
6. Demonstrate disaster mitigation approaches in the rehabilitation of damaged housing and construction of new housing in the communities damaged by Hurricanes Mitch and Georges.
7. Conduct evaluations and document the costs and performance attributes of PATH technologies that have been incorporated into recently completed demonstration projects.
8. Conduct extensive field testing and evaluations with builders, remodelers, and product manufacturers on the installation and field performance of innovative products, designs, and construction practices that contribute to enhanced resistance to fire and natural disasters.

9. Based on the results of previous evaluations, identify a set of high-priority technologies that, if accepted into practice, would help achieve PATH disaster mitigation goals.
10. Develop wide-ranging product and systems demonstrations throughout the U.S. incorporating high-priority PATH technologies. Evaluate methods for streamlining acceptance of advanced technologies and communicate the results to the industry and the general public.

Worker Safety

11. Develop partnerships and other cooperative efforts with the PATH partners to identify and address significant workplace hazards, emphasizing those targeted by OSHA's performance goals.
12. Deliver an appropriate mix of interventions and compliance assistance tools to assist homebuilders in complying with OSHA safety regulations.
13. Develop a valid, standardized safety and health program evaluation measurement tool that can be used to assess the quality of a safety and health program. Use the results from application of the tool to assist homebuilders in implementing or improving their safety and health programs.
14. Make safety and health information and materials easily accessible to homebuilders and workers via the Internet and paper-based publications.
15. Develop and disseminate occupational safety and health training and reference materials that address the needs of small homebuilders and workers.

ONGOING

Disaster Mitigation

1. Develop a "technology roadmap" to identify technological advances and a strategy to meet PATH goals, and form partnerships between government and industry to focus on high-priority industry needs.
2. Track and evaluate emerging technologies that can increase disaster resistance while not reducing housing affordability.
3. Challenge private-sector and public-sector partners to invest in the necessary R&D to create technologies that can be brought into practice by 2010.
4. Develop partnerships with manufacturers and builders to develop and test new, affordable, disaster mitigation technologies.
5. Establish pilot communities to demonstrate the constructability of tornado-safe, room shelter technology in residential structures.
6. Support pilot efforts to reduce monthly energy expenses in homes while concurrently reducing structural risk for natural hazards through the application of appropriate technologies, building practices, and property protection techniques.
7. In partnership with the manufactured housing industry, develop and implement better anchoring systems to resist high winds and seismic forces.

Worker Safety

8. Implement a method for acquiring data specially designed to measure incidence of residential construction workplace illness and injury.

9. Increase the use of technology-based training delivery systems (e.g., computer-based training and distance learning) to expand training opportunities for homebuilders and workers.
10. Track and evaluate emerging technologies that can improve worker safety while not reducing housing affordability.
11. Challenge private-sector and public-sector partners to invest in the necessary R&D over the longer term to create technologies that can be brought into practice by 2010.

Program Resources:

Role:

HUD	Postdisaster assessments Postdisaster technical assistance Research on technology developments Dissemination of results
USDA/Forest Products Lab	Wind resistance assessments Urban wildland/interface fire risk
FEMA	<i>Project Impact</i> disaster mitigation Disaster mitigation demonstrations Postdisaster mitigation demonstrations U.S. Fire Administration demonstrations/training/outreach
OSHA	Safety training for builders/remodelers
DOC/NIST	Housing performance standards Support to NES-BIC Residential fire safety research Program evaluation Cybernetic building system measurements Structural performance prediction Advanced wind standards
Product manufacturers	Product development Prototype testing/evaluation ISO-9000 quality programs
Builders/Remodelers	Identify technology needs Develop innovative practices ISO-9000 quality programs Installation assessments Market assessments

Evaluation:

The PATH baseline report contains data on fire and natural disaster incidence and losses that could be used to measure progress toward achieving PATH goals in fire and natural disaster reduction. OSHA maintains data on the incidence of illness and injury in the construction

industry but does not have the ability to disaggregate this data for incidence in residential construction.

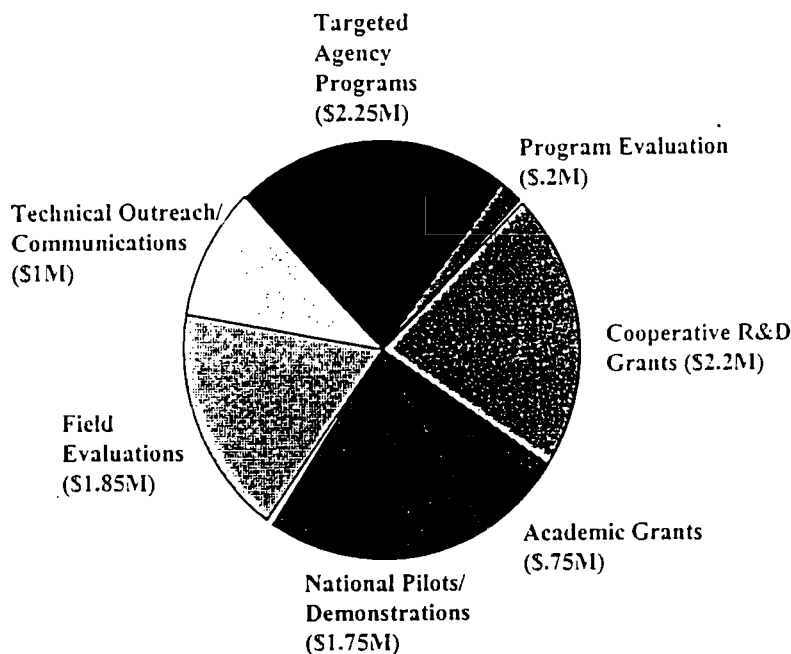
Communication Strategy:

An information and communications strategy is vital to the success of PATH's goal of advancing the use of housing technology. PATH's communications strategy promotes increased participation in PATH activities and promotes partners' efforts to achieve PATH goals. This multifaceted media effort—including the PATH Web site, brochures, newspaper and magazine articles, videos, conference exhibitions, and promotion on consumer-targeted television programs such as remodeling and homebuilding shows—will describe the importance of new housing and construction techniques, cite activities of partners using PATH technologies, and encourage industry as well as homeowner participation in the program. This communications strategy will be executed through the cooperative help of both agency and private-sector partners' public affairs offices.

V. Budget Planning & Milestones

In order for the \$10 million of PATH funds to have maximum impact on meeting the ambitious goals of the operating plan, HUD, with its public and private partners, has developed a program of grants, contracts, and interagency transfers to address the most pressing needs. This program, combined with investments by other Federal agencies will challenge private industry to invest more in housing technology research, stimulate basic academic research, leverage other Federal dollars, and address the most pressing need for the dissemination of technical information throughout the decentralized, disparate housing industry. The following chart shows how PATH funds will be allocated in FY 1999.

PATH FY99 Budgeting (\$10M)



This allocation of funds directly reflects operating plan priorities. For example, the \$750,000 for academic grants will be matched with an equal or greater amount of NSF funds to stimulate needed basic research. This will be the first NSF competition directed at residential housing technology, illustrating how PATH funds can leverage the resources of other Federal agencies. The \$1 million allocated for technical outreach responds to the priority in the operating plan given to improving the information infrastructure within the housing industry.

The operating plan requires HUD and its public and private partners to adhere to an ambitious agenda and schedule. A detailed action plan indicating all major program milestones will be

- submitted to Congress as part of the April progress report. Included in this action plan will be a series of projected major milestones for FY 1999 and FY 2000.

Major PATH Program Milestones for FY 1999 and FY2000

Cooperative R&D Grants with Industry

FY 1999	FY 2000
Sign Cooperative Research and Development Agreements (CRADAs) with 15 private sector firms who are matching the \$2.2M-Federal investment and developing technologies specifically directed at pressing technology needs .	Sign CRADAs with 15 additional firms who are developing technologies specifically directed at meeting the PATH goals. Promising new technologies will be incorporated into the field evaluation and demonstration activities.

Targeted Research Grants at Academic Institutions

FY 1999	FY 2000
Provide grants through NSF to 25 academic institutions for research directed at targeted research needs in the PATH program.	Provide grants through NSF to 25 additional academic institutions for research directed at targeted research needs in the PATH program. Feed results into the PATH field testing and demonstration initiatives.

National Pilot Projects and Demonstrations

FY 1999	FY 2000
Initiate broad-based technical assistance to at least 5 national well-recognized pilots that will demonstrate a wide variety of PATH technologies to a broad audience.	Continue providing technical assistance to the national pilot projects to demonstrate a wide variety of PATH technologies to a broad audience.
Provide technical assistance to 10 national demonstrations working with builders and developers at the subdivision level to demonstrate and evaluate PATH technologies.	Expand to 20 the number of national demonstrations featuring advanced technologies that can help the building industry meet the PATH goals.
Initiate PATH demonstrations with at least 2 Indian tribes and 2 Hope VI sites. As part of this effort, build at least 50 homes at Pine Ridge that use PATH technologies.	Continue providing technical assistance to the 2 Indian tribes and 2 Hope VI sites. As part of this effort, build 250 additional homes at Pine Ridge incorporating PATH technologies.

Demonstrate Nationally Applicable Recommended Rehabilitation Provisions (NARRP) in at least 2 communities and have NARRP included in the International Residential Code published by the International Code Council (ICC).	Demonstrate the NAARP in another 5 communities and work to get the NAARP adopted, either directly or through the adoption of model codes, in at least 20 communities.
Demonstrate the "Next Generation" Manufactured home in 3 developments with at least 1 manufacturer adding the advanced techniques to its product line.	Demonstrate the "Next Generation" Manufactured home in 3 additional developments with at least 3 manufacturers adding the advanced techniques to their product lines.
Build a set of four Marketable Affordable Durable and Entry-Level (MADE) homes in a model subdivision and evaluate cost, performance, and marketability of this concept.	Evaluate the installed costs and monitor the performance of the materials and systems incorporated into the MADE homes.
Demonstrate the application of disaster mitigation techniques in homes being retrofitted through DOE's Weatherization Program.	Evaluate the cost impacts of adding disaster mitigation techniques in homes retrofitted through DOE's Weatherization Program.
As a joint effort between HUD and FEMA, demonstrate the use, actual construction costs, and cycle-time impacts of "safe rooms" in 10 homes.	Document the actual construction costs and cycle-time impacts of "safe rooms" demonstrated in 10 homes.

Field Testing and Evaluations

FY 1999	FY 2000
Apply evaluation criteria to the 200 technologies that have been identified by the program to date and determine a subset of 25 technologies with near-term potential to help the housing industry meet PATH goals. Incorporate these technologies into field evaluation and demonstration activities.	Apply evaluation criteria to another 100 technologies that will be identified by the program and determine a subset of 25 additional technologies with near-term potential to help the housing industry meet PATH goals. Incorporate these technologies into field evaluation and demonstration activities.
In cooperation with the model codes and the National Evaluation Service, develop evaluation plans for at least 25 emerging technologies and complete the comprehensive evaluation of at least 10 technologies.	Develop evaluation plans for 30 additional emerging technologies and complete comprehensive evaluations of at least 25 technologies.
Evaluate with builders and remodelers the field performance of 15 innovative technologies prior to their widespread adoption.	Evaluate with builders and remodelers the field performance of 25 additional innovative technologies prior to their widespread adoption.

Technical Outreach/Communications

FY 1999	FY 2000
Establish HOMEBASE as the primary source of reliable technical information for the housing industry by providing a toll-free technical hotline to at least 8,000 builders and remodelers per year, a technical newsletter to at least 70,000 firms quarterly, a comprehensive Catalog of Building Products and Services published on CD-ROM and on the Internet that is distributed to at least 60,000 firms annually, and a technical Web site with useful technical information on emerging homebuilding technologies.	Expand HOMEBASE services to include a comprehensive search tool for builders and remodelers seeking documented information on the performance of advanced products and systems, a distance-learning component to provide educational seminars to the widest possible audience (delivery of 12 technical seminars through the distance-learning tool), and advanced ISO-9000 training techniques for builders and their contractors.
Promote outreach through industry venues including conferences, periodicals, and existing homebuilder programs.	Promote outreach through industry venues including conferences, periodicals, and existing homebuilder programs.
Develop a major consumer outreach component for the PATH program that will introduce the general public to the benefits of living in a "high-performance home that is less expensive to own and operate."	Expand the consumer education and awareness campaign by coordinating the communications resources of PATH participating agencies and their industry partners.

Targeted Agency Programs

FY 1999	FY 2000
Document the cost and performance results of the projects funded under the DOE Building America program.	Continue documenting the cost and performance results of the projects funded under the DOE Building America program and disseminate lessons learned to the building industry and consumer audiences.
Incorporate the full spectrum of PATH goals and Federal resources into additional Building America sites as selected.	Incorporate the full spectrum of PATH goals and Federal resources into additional Building America sites as selected.
Conduct an industrywide needs assessment through NIST and industry partners of durability issues in residential construction and produce a research and technology agenda.	Conduct research projects based on high-priority needs identified in the needs assessment and assign priority areas in the NIST/PATH CRADA process for needed technology development.
Conduct a research needs assessment for wood product use in housing in cooperation with university and industry researchers.	Conduct research projects based on the results of the wood industry needs assessment and provide priority areas to NSF to include in the targeted grants for academic institutions.
With other PATH partners, university and industry researchers, USDA Forest Service will continue distribution of research findings and conduct a conference/workshop on durability issues in housing.	Conduct additional conferences/workshops on durability issues in housing through USDA Forest Service.

Program Evaluation

FY 1999	FY 2000
Set up a procedure through DOC/NIST for measuring progress toward meeting PATH goals.	Conduct an annual evaluation of progress toward meeting PATH program goals.
Conduct an independent evaluation of the operations of the PATH program.	Conduct an independent evaluation of the operations of the PATH program.

Partnership for Advancing Technology in Housing (PATH)

Near Term Publicity Events

Revised: May 25, 1999

Sorted by Date

Project	Location	Dates	Description/Current Status
Armory Park del Sol	Tucson, AZ	Late June, 1999	The Armory Park del Sol project represents one of the first commitments to the new Million Homes initiative as part of the Livable Communities agenda in which a blighted infill site will be developed with highly energy efficient, affordable homes using labor in part from a non-profit program to provide skills based training for homeless people. Groundbreaking on this site is scheduled for late June, 1999 and the timing is flexible.
Heather Hills <i>Home of the Future</i>	Simi Valley, CA	June 28, 1999	A PATH demonstration project sponsored by Southern California Edison and built by Beazer Homes with technical assistance by HUD. The ribbon cutting for this house is scheduled for June 28, 1999. The house features a range of innovative "green" building technologies that provide a higher performance house while reducing the cost of owning and operating the house.
Pine Ridge PATH Blitz Build	Pine Ridge Reservation, SD	August 1999	PATH will provide technical support this summer to a major "blitz build" project on the Pine Ridge Reservation in South Dakota where 50 homes will be built in the space of one week in early August and a "technology showcase" will demonstrate advanced technologies for the 350 visiting tribal leaders from around the nation. Housing conditions on Native American reservations nationwide are substandard. Pine Ridge offers an opportunity to break this cycle by promoting ways for families not only to own their own home but to live in a house that is energy efficient, comfortable and durable.
Marketable, Affordable, Durable and Entry-Level (MADE) Houses	Bowie, MD	August 1999	A major planning and design process involving builders, architects, research professionals, manufactured housing providers, product manufacturers and HUD led to the development of a design for four houses in the NAHB National Research Home Park near Washington, DC that are marketable, affordable, durable and entry-level. Groundbreaking is scheduled for August.
21 st Century Townhouses in NAHB National Research Home Park	Bowie, MD	Available for Press Events Anytime. 30 Minutes from DC	Advanced housing technologies featured in the PATH program have been incorporated into a four unit townhouse project in the NAHB National Research Home Park in Bowie, MD. One of the houses features the first photovoltaic solar electric rooftop, in which the metal roofing for the house actually serves as the power plant for the home owners by converting sunlight into electricity. The solar electric rooftop blends in aesthetically with the other rooftops in the townhouse development. The HOMEBASE program is a communications infrastructure for the 200,000 companies involved in residential construction making it possible for them to learn more rapidly of the advances in technology that are becoming available.
Washington Square Seniors Townhouses	La Plata, MD	Early Fall, 1999	This is the opening of an 80-unit seniors townhome project in southern Maryland with promotional sponsorship from the Portland Cement Association. A range of innovative technologies – some of them concrete based – are featured in the units. The units are designed to require minimal utility bills, excellent indoor environment, acoustical isolation from nearby railroad tracks, resistance to high winds, and affordability.

Project	Location	Dates	Description/Current Status
PATH Advanced Wood Technology Demonstration House on the Mall	Washington, DC	Late 1999 or Spring 2000	The U.S. Forest Service, in conjunction with APA, The Engineered Wood Association and other participating PATH partners are planning to build a high-profile demonstration house on the Mall in Washington, DC in the fall. We expect extensive media coverage and large numbers of tours from the general public.
The International Builders Show and Exposition	Dallas, TX	January 2000	Over 70,000 builders, remodelers and product manufacturers attend the largest exposition of building products in North America each January. Advanced building products are demonstrated throughout the exposition and seminars demonstrate how to incorporate new technologies into their housing projects. This is the premier opportunity to address the 1700 member Board of Directors from around the country of the National Association of Home Builders.
The National Green Builders Conference	Denver, CO	April 2000	This is the first conference on resource-efficient construction for the mainstream home builder. It features leading-edge builders, developers, and practically minded building scientists focusing on the design, development, construction, marketing, and financing of homes that are environmentally-sensible and sought out by consumers. Over 450 builders attended in 1999.
Stapleton Airport Development	Denver, CO	September 2000	Stapleton Airport development is another National Pilot Project for the PATH program. Forest City Development was recently chosen as the developer of the site. It will be moving to land planning and building design in the coming year.
Playa Vista	Los Angeles, CA	September 2000	The press conference to announce the release of the Sustainable Development Guidelines for the Playa Vista project in Los Angeles was held on March 25. This is one of the five Presidential National Pilot sites for the PATH program. Over 500 homes in the first phase of sustainable development are scheduled to open at once in a major opening ceremony in September 2000.
Village Green	San Fernando Valley, CA	No new publicity events currently planned.	This is one of the PATH National Pilot site and is where President Clinton launched the PATH program on May 4, 1998. The Lee Group has now completed model homes for a ribbon cutting that was held on May 13. DOE A.S. Dan Reicher spoke at the event. Twenty production houses based on these advanced technology affordable model homes began construction in March.
Summerset	Pittsburgh, PA	No new publicity events currently planned.	A ground breaking ceremony was held for the Summerset National PATH Pilot Project on May 17 in Pittsburgh, PA. DOE A.S. Dan Reicher spoke at the event. Summerset is a "brownfields" site that will require environmental remediation in order to prepare the site for the sustainable development project within the city of Pittsburgh.
Civano	Tucson, AZ	Houses under Construction.	Civano is the large sustainable development project in Tucson that is one of the President's National Pilot sites for the PATH program. A community center and the models were included in a ribbon cutting ceremony in April 1999.

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PATH Coordinating Council Working Group Sign-ups

Revised: May 7, 1999

Based on the Mailing List for the PATH Coordinating Council

Company	First Name	Last Name	Title	Phone	Fax	#1 T.R.	#2 Fin.	#3 B/I	#4 Q/L	#5 C.E.E.
American Institute of Architects	Mark	Hurwitz	CEO	202-626-7310	202-626-7426					
American Institute of Architects	Daniel	Wilson	Dir., Fed. Affairs	202-626-7384	202-626-7365					
Andersen Corporation	Donald	Garofalo	Exec. Pres/COO	651-439-5150	651-439-5107					
Andersen Corporation	Glenn	Hause	Res. Mkt. Mgr.	651-439-5150	651-430-5485					
Andersen Corporation	Kurt	Heikkila	Sr. V.P. for Tech.	651-430-7327		✓		✓		✓
Andersen Corporation	Mike	Koenig	Mgr., Matl Devel	651-430-7362						
Andersen Corporation	Guy	Reithmeyer	Mgr, Codes/Reg.	651-430-7243	651-439-5107					
Armstrong World Industries	Gordon	Lorch	Pres./CEO	717-397-0611	717-396-6046					
Armstrong World Industries	Michael	Otchet	Assoc. Counsel	717-396-2157				✓		
Armstrong World Industries	Jim	Work	Mgr., Bldg Innov	717-397-0611	717-396-5284					
Asdal Builders	Bill	Asdal	President	908-879-4427	908-879-2641					
Carrier Corporation	Richard	Fedrizzi	Dir. Mkt. Comm.	315-432-7393	315-432-3213					
Carrier Corporation	John	Lord	Chairman	860-674-3000	860-674-3139					
Center to Protect Workers' Rights	Robert	Pleasure	Exec. Director	202-962-8490	202-962-8499					
Centex Homes	Tim	Eller	Pres., CEO	214-981-6118	214-981-6000					
Centex Homes	Randy	Luther	Direc., R&D	214-981-6118	214-981-6000	✓				
CertainTeed Corporation	Bruce	Cowgill	Pres., Insulation	610-341-7325	610-341-7057					
CertainTeed Corporation	Ken	Knapp	Res. Prod. Devel.	610-341-6737	610-341-6773	✓				
CertainTeed Corporation	Brad	Mattson	EVP	610-341-7922	610-341-7112					
CertainTeed Corporation	Glenn	Singer	Direc., Res. Mkt.	610-341-7673	610-341-7571	✓			✓	
Champion Enterprises	C. Edgar	Bryant	VP, Engr.	248-340-7689	248-340-7777	✓				
Champion Enterprises	Walter	Young	Chairman/CEO	248-340-7727	248-340-9345					
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Dow Chemical Co.	Richard	Gross	VP/Dir. R&D	517-636-5199	517-636-5832					
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Enterprise Foundation	Bill	Duncan	Dir. Production	410-964-1230	410-964-1918					
Enterprise Foundation	Michael	Downie	Program Director	410-964-1230	410-964-1918					
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Fannie Mae	Franklin	Raines	Chairman	202-752-7380	202-752-5980					
Federal Home Loan Bank/Boston	Michael	Jessee	Pres., CEO	617-330-9872	617-292-9645					
Federal Home Loan Bank/Boston	David	Parish	Sr. VP, Hsg. Inv.	617-330-9872	617-292-9645		✓			
Federal Housing Finance Board	Diane	Dorius	A.D., Policy	202-408-2576	202-408-2915		✓			
Fleetwood Enterprises	Glenn	Kummer	President	909-351-3500	909-351-3373					

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General Electric Appliances	Brian	Sherry	Mkt. Mgr.	502-452-3071	502-452-0383					
Glunt Development Corp.	Roger	Glunt	President	412-824-9750	412-824-3892					
Habitat for Humanity International	Thomas	Jones	Managing Direc.	202-628-9171	202-628-9169	✓	✓			
Habitat for Humanity International	Jane	Maloney	A.D., Natl. Prog.	202-628-9171	202-628-9169	✓	✓			
Home Depot	Larry	Mercer	EVP of Ops/Gr.P	770-384-2656	770-384-3758					
Home Depot	Kim	Woodberry	Mgr. Envir. Prog.	770-384-2656	770-384-3758					
Honeywell	Paula	Prahl	Dir., Policy Dev.	612-951-3232	612-951-0126					
Honeywell	Glen	Skovholt	VP, Govt. Affairs	612-951-0050	612-951-0110					
Honeywell	Albrecht	Weiss	Pres., Home Con.	612-951-3494	612-951-3757					
Honeywell	Kim	Zurcher	New Cons. Sales	612-954-4858	612-964-4440	✓				✓
IBM, Home Networking	Craig	Merrigan	Group Mkt. Mgr.	919-486-2679		✓				✓
Institute for Bus. and Home Safety	James	Russell	VP, Prog. Coord.	617-292-2003	617-292-0202			✓		
Institute for Bus. and Home Safety	Harvey	Ryland	Pres., CEO	617-292-2003	617-722-0202					
International Code Council	Richard	Kuchnicki	CEO	703-931-4533	703-379-1546	✓		✓		
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Kohler Company	John	McNeil	Dir., Bus. Devel.	920-457-4441	920-459-1834					
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Lucent Technologies	Ken	Frankel	Natl. Acct. Mgr.	201-493-1829	201-493-1862					
Lucent Technologies	Jacqueline	Totten	Dir., Home Star	973-581-4311	973-581-3670					
Lucent Technologies	Carleton	Fiorina	Pres. Global Serv	732-969-3683						
Lucent Technologies	Richard	McGinn	Chairman, CEO	908-582-8500	908-508-2576					
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Manufactured Housing Institute	Chris	Stinebert	President	703-558-0401	703-558-0401					
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Masonite Corporation	Don	Walker	Natl. Sales Mgr.	312-634-2662	312-634-2850					
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Maytag Corp.	Lloyd	Ward	Pres., CEO	515-792-7000	515-787-8477					
Maytag Corp.	Mark	Wilson	Mgr., Ind. Comm	515-787-6848	515-787-8570					
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Natl. Home Energy & Resources	Steven	Lowrie	President	804-560-9134	804-560-9139		✓			
National Evaluation Service	Billy	Manning	President	205-599-9888	205-599-9850			✓		✓
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Oakwood Homes Corp.	Robert	Harvey	VP/Admin.	336-664-2400	336-664-3224					
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Owens Corning	Glenn	Hiner	Chairman/CEO	419-248-6518	419-248-6352					
Owens Corning	Steve	Gallagher	Mgr./Govt. Rel.	202-393-2765		✓				✓
Owens Corning	Warren	Wolf	VP/S&T	740-321-7525		✓				
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Russell Enterprises	Dennis	Russell	President/CEO	760-739-5977	760-739-5984					
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Schult Home Corporation	Walter	Wells	President	219-825-5881	219-825-5880					
Simpson Strong Tie	Norman	Hall	Mgr./Factory Blt.	732-449-1413	732-449-1438					
Simpson Strong Tie	Randy	Schackelford	Research Engr.	800-999-5099	972-548-0924					
Simpson Strong Tie	Thomas	Fitzmyers	Pres./CEO	800-925-5099	925-847-9114					
Solutia Inc.	Robert	Potter	CEO	314-674-1000	314-694-8425					
Solutia Inc.	Martha	McAlister	Global Merch Dir	314-676-3550	314-694-3439					
Southdown, Inc.	Clarence	Comer	Pres./CEO	713-653-8000	713-653-8010					
Southdown, Inc.	Mike	Haney	Dir. Corp. Devel.	713-653-8557	713-653-8010					
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Southern California Edison	Gregg	Ander	Chief Architect	909-394-8734	909-394-8597	✓				
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State Farm Insurance	Alex	Thompson	Asst. VP	309-766-6183			✓			
State Farm Insurance	Teri	Spalding	Mgr. Research	309-766-7044	309-766-3662			✓		
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Texas A&M	Charles	Graham	Chairman	409-845-0216	409-862-1572					
Toll Brothers	Robert	Toll	Chairman/CEO	215-938-8020	215-938-8023					
United Brotherhood of Carpenters	J. Dudley	Light	Exec. Director	202-546-6206	202-546-3054					
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U.S. Gypsum	William	Foote	Pres/CEO	312-606-4000	312-606-3780					
USAA	Wilson	Cooney	Deputy CEO	210-498-4925	210-498-0385			✓		
USAA	Craig	Horton	Asst. VP	757-893-4850	757-893-5859			✓		
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PATHways

Technology making a difference where Americans live

Village Green Sets Pace With Next-Generation Technology

The insulation is extra thick, a commuter train stops just outside the front door, the gas-fired cooling systems use no ozone-destroying agents, and solar electric roof panels generate much of the electrical energy necessary to run appliances.

Is this a home of the future? Yes. But for new homeowners at Village Green in Los Angeles' San Fernando Valley, the future begins now. Last year President Bill Clinton launched the Partnership for Advancing Technology in Housing (PATH) during groundbreaking ceremonies for Village Green. The President said, "PATH will be the most ambitious effort ever to help private homebuilders and homeowners make cost-effective decisions that will pay big dividends through the 21st century." He proclaimed Village Green a PATH National Pilot Project, a community that would be a model for the U.S. construction industry because of its new approaches to land planning and design and its highly innovative technologies. The first three model homes opened May 13. By the end of this year, 60 of the planned 186 energy-saving homes will be built. Each home is being built to fulfill the President's promise.

Success requires careful planning. The builders of Village Green, Lee Homes by the Lee Group and Braemar Urban Ventures, along with their financial partner, the American Communities Fund, planned from the outset to build outstanding, affordable housing for first-time buyers. They selected 18 acres next to a Metrolink transit station for the single-family detached homes. The future community of Village Green was surrounded by development. Such a location, called

an infill site, cuts costs because utilities and roads are already in place. The location also means that the new community will contribute to the existing, greater urban environment itself, rather than extend urban sprawl. Village Green's proximity to a transit station also qualified it for a grant under the Intermodal Surface Transportation Efficiency Act to improve access and use of the Metrolink and feeder bus lines.

The Village Green homes face their neighbors. This allows the builders to place 38 homes on

(continued on page 2...)



About PATH

Welcome to the inaugural issue of PATHways, the bimonthly newsletter of the Partnership for Advancing Technology in Housing (PATH). At the U.S. Department of Housing and Urban Development (HUD), housing is our business and providing affordable housing in safe neighborhoods for all Americans is our mission. PATH, a private-public partnership announced by President Clinton last year, aims to dramatically improve the quality, cost effectiveness, durability, safety, and disaster resistance of housing in the United States. PATH represents the many ways that HUD, in partnership with other federal agencies, private industry, and professional associations (such as the National Association of Home Builders), is working to build affordable, environmentally friendly homes in livable communities across America.



The PATH program enhances livable communities in two distinct ways. New technologies almost always make housing more affordable over the long run because they are more energy efficient and reduce maintenance. New technologies are also more environmentally friendly, reducing air toxins and gas emissions.

Currently, a number of housing technologies identified by the PATH program are being used by national pilot sites in Los Angeles and Tucson.

The United States has the best housing system in the world, and HUD is proud to take a leadership role in PATH to promote, expand, and use new technology to make housing better for all Americans.

—Andrew Cuomo

Secretary of Housing and Urban Development



PATH Partners

PATH public-sector partners include the following federal agencies:

- U.S. Department of Agriculture
- U.S. Department of Commerce
- U.S. Department of Defense
- U.S. Department of Energy
- U.S. Department of Housing and Urban Development
- U.S. Department of Labor
- U.S. Department of Transportation
- U.S. Environmental Protection Agency
- Federal Emergency Management Agency
- National Science Foundation
- White House Office of Science and Technology Policy

PATH private-sector partners include representatives from the homebuilding industry, insurance and financial companies, retailers, and professional associations. State and local officials committed to facilitating the use of new technologies in housing projects within their jurisdictions also participate in the program.

PATH is administered by HUD. For program information on the PATH initiative or to be added to the PATH mailing list, call the PATH offices at (202) 708-4277.

Visit PATH online at www.pathnet.org.

To request publications, including future issues of PATHways, call (800) 245-2691 or (800) 483-2209 (TDD).

For technical information call HOME BASE at (800) 898-2842.

(...continued from page 1)

Village Green

existing roads, thus reducing the amount of roads necessary for the remainder of the development. The builders' offer to work with surrounding homeowners to make necessary improvements to their existing homes, their decision to build a nongated development that facilitates access through Village Green to the Metrolink station for area residents, and the creation of a 25,000-square-foot park in the center of the development open to the public made Village Green a welcome part of the greater community from its beginning.

This public goodwill translated into municipal help in everything from provision of specially sized sewer lines to curbside recycling services for the new community. The Village Green builders worked closely with Los Angeles city departments including planning, public works, building and safety, and water and power to interpret city codes and reduce unnecessary delays.

The builders also pursued financing tools with the city of Los Angeles, Fannie Mae, and the Southern California Gas Company (SoCalGas) to increase affordability through lower mortgages and closing costs. One program developed by Fannie Mae, called a location-efficient mortgage, offers a reduced mortgage rate due to Village Green's proximity to the Metrolink and transit center. A number of lenders also agreed to reduce closing costs by \$500 because Village Green meets SoCalGas's energy-efficiency standards.

The President's announcement of Village Green as a PATH National Pilot Project triggered immediate action. A PATH National Pilot Project team, led by the U.S. Department of Energy's (DOE's) Building America program, presented design, construction,



and technology recommendations derived from the construction of test homes and extensive laboratory and computer analyses by the nation's foremost experts in building science and technology.

Village Green's builders used Building America's systems engineering approach. Decisions, once made independently, considered the entire design, manufacturing, and construction processes, thereby increasing quality and performance without increasing cost.

The optimum approach for healthy, safe, comfortable, energy-efficient homes is to construct a tight building envelope (the barrier between the interior of a house and outside elements) and provide controlled mechanical

ventilation. Village Green adopted that practice.

Village Green uses state-of-the-art building materials and systems. Steel-framed wall components and advanced framing systems made with engineered wood products reduce the amount of lumber used, leaving more room in the walls for insulation.

Each home is insulated with cellulose insulation, which provides a *superinsulated* wall assembly. An innovative, forced-air duct distribution system ensures that all ductwork is contained within the home's thermal barrier. No ductwork is located in exterior walls or attic spaces, so energy costs for heating and cooling are lower.

The use of key draft-stopping provides for a much tighter building envelope—50 percent tighter than standard construction—that eliminates drafts and improves comfort and energy efficiency.

A revolutionary window glazing system lets visible light through, but keeps the solar heat out in summer and the heat inside in winter. The substitution of vinyl for metal in the window frames increases the insulating properties of the windows. The dual-glazed windows also block 87 percent of ultraviolet rays, reducing fading and damage to rugs and fabrics inside.

The tight building envelope enabled the builders to downsize heating and cooling equipment by 50 percent. The builders replaced the furnace and the traditional water heater with an integrated space-heat combination system. A gas water heater in the garage (outside the building envelope) pumps instant hot water into the house and supplies space heat through a water-to-heat exchanger or fan coil in the winter.

To demonstrate new, emerging technologies and to reduce high demands for electricity in the summer months, SoCalGas, DOE, and the Robur Corporation are providing financial assistance for the installation of natural gas absorption chillers (GAX) in each Village Green home. The air cooling systems, which use chilled water for air conditioning, use natural gas with no ozone-destroying agents. With the support of BP Solar Corporation and the Los Angeles Department of Water and Power, Village Green is installing rooftop photovoltaic panels. The solar energy arrays will provide up to 90 percent of each household's average electrical demand.

(continued on page 4...)

Products To Change the Way Americans Live

Whether you are renting, planning to buy a new home, or interested in ways to remodel your existing home, this section of *PATHways* has some good information for you. Each issue will focus on products that are changing the way America lives.

Horizontal Axis Washer and Diagonal Air Flow Dryer



Public laundromats have long favored front-loading washing machines. These water-saving machines are now available for home use. Commonly referred to as *horizontal axis washing machines*, these washers tumble clothes like a dryer instead of agitating them. According to the U.S. Environmental Protection Agency, horizontal axis washing machines use about 40 percent less water and 50 percent less electricity per load.

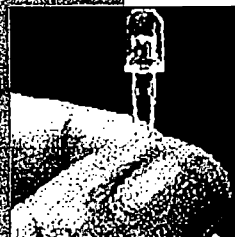
New high-speed, diagonal airflow dryers are a great complement to horizontal axis washing machines. These new machines dry clothes quickly and efficiently. To shorten ironing time, airflow dryers help clothes "billow" to reduce wrinkling during the drying process. Many airflow dryers feature electronic sensors to measure the moisture content of clothes. These "smart" dryers automatically shut off heat when the clothes are dry, reducing unnecessary energy use and electric bills.



Fiber-Cement Siding

Do you want the look of wood siding without the loss of heating and cooling inside your home? Check out fiber-cement siding. Composed of cement, sand, and cellulose fiber, this product is more durable than wood. It is installed over studs or exterior wall sheathing and

then coated with a water-resistant barrier. Your builder will have no trouble installing fiber-cement siding, because the process is the same as working with wood. It is termite resistant and noncombustible, and has a 50-year warranty. Best of all, fiber-cement siding can be painted to enhance your home's appearance.



White LED Lighting

If you thought fluorescent lighting was efficient, wait until you hear about light-emitting diode (LED) lamps. They consume less than 25 percent of the electricity used by fluorescent lights, and the lamps last 10 times as long. White LED lights have been around for a long time. They have been a staple of recreational vehi-

cles, boats, and early solar house prototypes. The price of LED lights has unfortunately been prohibitive for most Americans. Thanks to new technology, however, LED lights cost a fraction of their former price. Now all homeowners can afford LED lamps inside their home and choose from an array of choices for exterior home and garden lighting.

If you want more information, check out PATH's website at www.pathnet.org. You will find contact numbers, product descriptions, and information on the benefits, limitations, costs, and availability of more than 130 new products and technologies for the home.

Builder's Manual Profiles Affordable, Entry-level Homes

To increase the number of site-built, entry-level homes, HUD's Office of Policy Development and Research recently released a manual that illustrates how developers can construct high-quality, energy-efficient, durable, and affordable housing. *A Builder's Guide to Marketable, Affordable, and Durable Entry-level Homes (MADE) To Last*, developed as a part of PATH, provides builders with:

- Tools to market affordable housing to entry-level buyers.
- Successful techniques for building affordable, durable housing.
- Methods to define homebuyer expectations and fulfill their needs both before and after the sale.
- Preliminary plans illustrating how many of these techniques fit into a MADE-to-last demonstration home.

To develop the MADE prototype, researchers consulted housing experts and surveyed first-time homebuyers and some of the nation's top affordable homebuilders. They also reviewed

statistics on home sales, housing characteristics, and durability issues. Although they are price conscious, first-time buyers want attractive homes, the ability to expand them for growing families, and flexible floor plans. The manual provides tips on how to achieve these characteristics while controlling construction costs. Case studies also provide insight into how builders are successfully using these techniques.

Another section focuses on reducing home maintenance costs. The guide looks at ways to increase durability and prevent problems that increase maintenance costs, such as poor drainage, foundation wall cracks and water leakage, soil swelling or settlement, termites, and buckled siding. The manual includes preliminary plans for a MADE-to-last home.

Copies of *A Builder's Guide to Marketable, Affordable, and Durable Entry-level Homes (MADE) To Last* are available from HUD USER for \$5. For more information or to order online, visit the HUD USER website at www.huduser.org/publications/destech/made.html or call HUD USER at (800) 245-2691.

(...continued from page 2)

Village Green

A controlled ventilation system complements the tight, energy-saving building envelope. The system enhances indoor air quality, comfort, and freshness by bringing in outside air when needed by the occupants. The ventilation system also eliminates the buildup of odors or pollutants and the possible entrance of soil, gas, radon, and pesticides.

Village Green homes meet the Engineered for Life standard and surpass the Model Energy Code. Monthly energy bills are anticipated to be as low as 50 percent of those of older, conventional homes. Village Green homes also qualify for the U.S. EPA's ENERGY STAR® program. An ENERGY STAR® home reduces air pollution and helps reduce utility bills.

Innovations employed by Village Green produce energy efficiencies that are expected to translate into heating and cooling bills 30 percent lower than those of typically constructed

homes. Greenstone, the insulation company, guarantees that a Village Green homeowner will pay no more than \$40 per month for energy bills during the first 2 years.

Public interest in the two-story, detached, single-family homes is excellent: The first 18 homes currently under construction have been sold, and a waiting list has begun for the others. Each home features 3 or 4 bedrooms, 2½ baths, up to 1,700 square feet of living space, and a 2-car garage. Prices begin at \$160,000, with monthly payments as low as \$1,000.

Jeff Lee of Lee Homes said, "This experience has changed the way we build homes. We are going to put energy-efficient technology into our homes in the future. Homebuyers want and appreciate this technology, particularly the cost savings." Lee cautions, however, that "Technology alone is not enough. The price must be right. Success is a pocketbook issue. We show people that these innovations save them money each month. The homebuyers

By 2010 PATH goals are to use new technology:

- To reduce the monthly cost of new housing by 20 percent or more.
- To cut the environmental impact and energy use of new housing by 50 percent or more and by 30 percent in 15 million existing homes.
- To improve housing durability and reduce maintenance costs by 50 percent.
- To reduce the risk of loss of life, injury, and property destruction from natural hazards by at least 10 percent.
- To decrease residential construction work illnesses and injuries by at least 20 percent.

Focus on PATH's Federal Partners

The Department of Energy

The U.S. Department of Energy's (DOE's) Office of Building Technology, State and Community Programs (BTS) supports a variety of PATH-related activities. Working with industry, BTS develops, promotes, and integrates energy technologies and practices to make buildings more energy efficient.

BTS works toward this goal by accelerating the introduction of highly efficient technologies and practices through research and development; increasing the minimum efficiency of buildings and equipment through codes, standards, and guidelines; and encouraging the use of energy efficiency and renewable energy technologies and practices through technology transfer and financial assistance.

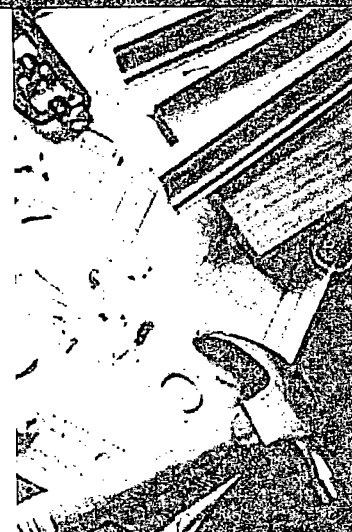
Partnership opportunities for builders and designers include BTS's Building America program, which provides assistance to PATH's National Pilot Projects. The Building America Program (www.eren.doe.gov/buildings/building_america) works to reduce energy use by as much as 50 percent. Participants adhere to a systems engineering approach to homebuilding that unites segments of the building industry that traditionally work independently of one another.

The systems engineering approach recognizes that features of one component in a house can greatly affect others and it enables teams to incorporate energy-saving strategies at no extra cost. The program aims to facilitate the adoption of a systems engineering approach in 70 percent of the new housing market within 10 years.

DOE/BTS-funded research also produces advances in lighting, windows, insulation, building materials, appliances, weatherization, and whole-building design. The General Accounting Office estimates more than \$33 billion in potential savings from BTS technologies. BTS researchers, in partnership with the Association of Home Appliance Manufacturers, have developed a 20-cubic-foot refrigerator-freezer that uses only 1.04 kilowatt-hours of electricity per day, half the current standard.

Building engineers and architects are also using BTS-developed software design tools to

increase the efficiency and lower the environmental impact of new and retrofitted construction. Computerized modeling tools such as "Designing Low Energy Buildings" and "DOE-2" help designers integrate energy-efficient and renewable-energy components and systems into building plans at the blueprint stage. Data on all aspects of a building's site (climate, shading, orientation), materials (wood, brick, insulation, windows), and equipment (chillers, lighting, computers) go into



Under the PATH Roof

Here are a few tips to help keep homes safe and energy efficient.

1. *Test your home for radon, a naturally occurring gas that is unsafe for prolonged human exposure. If you uncover levels that are above the U.S. Environmental Protection Agency's recommended levels, call (800) 557-2366 to find out ways to reduce radon to acceptable levels.*
2. *In addition to smoke detectors, homes with fireplaces, gas appliances, and attached garages should have carbon monoxide (CO) detectors. Undetected by the eye or nose, carbon monoxide gas can be fatal. Local fire departments sometimes provide CO detectors at low cost, and many home improvement stores carry CO detectors.*
3. *Well-insulated basements and crawlspaces reduce the likelihood of frozen pipes in the winter. Give your home insulation a boost by replacing it with one of the new cellulose-based, recycled paper insulating products.*
4. *Save on your homeowner's insurance. Each time you make a safety upgrade on your home, notify your home insurance agency. These upgrades can mean big savings on insurance. Many companies will reduce premiums by 10 percent to 20 percent annually, depending on upgrades.*

For more information, contact:

*PATH at (202) 708-4277 or visit PATH's website at www.pathnet.org.
HUD's Healthy Homes Program at (800) HUDS-FHA or www.hud.gov.*

calculations to optimize building performance and occupant comfort and productivity.

DOE's Building Codes & Standards Program (www.eren.doe.gov/buildings/codes_standards) works with states and localities to update and implement building energy codes. Appliance standards on air conditioners, furnaces, and dishwashers help consumers save money. In some cases, manufacturers have developed innovative, energy-efficient products in anticipation of future revised standards, making energy awareness a competitive factor in the marketplace.

DOE's State and Community Partnerships Program has a Weatherization Assistance

(continued on page 6...)



(continued from page 5)

Department of Energy

Program (www.eren.doe.gov/buildings/state_and_community/weather) that has improved the energy efficiency of 75,000 existing homes by 23 percent. The Weatherization Assistance Program can serve as the basis for meeting PATH's goal of achieving a 30-percent reduction in energy use in 15 million existing homes.

DOE's Solar and Renewable Energy Program includes the President's Million Solar Roofs initiative (www.eren.doe.gov/millionroofs) with a goal to place 1 million solar energy systems on U.S. buildings by 2010.

DOE websites are not just for researchers. With a click of a mouse, builders and homeowners can access information on everything from Using Solar in Your Home (www.eren.doe.gov/buildings/home_solar.html) to materials to consider when building an addition to the old homestead (www.eren.doe.gov/buildings/home_building.html) to Tips on Saving Energy Money at Home (www.eren.doe.gov/)

Calendar of PATH Events

July 20-24, 1999

HUD invites you to participate in the 1999 Best Practices and Technical Assistance Symposium in Kansas City, Missouri. For more information visit the HUD website at www.hud.gov or call this toll-free number: (877) 747-3861.

July 22, 1999

Attend the PATH symposium on 21st century housing in Orlando, Florida, in conjunction with the 1999 Southeast Builders Conference. Topics will range from new building systems to the effect of an aging population on the housing industry. The symposium fee is \$25. For registration information call the Florida Home Builders Association at (850) 224-4316.

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**Agenda for the
Partnership for Advancing Technology in Housing (PATH)
Principles Interagency Council (PIC)
June 2, 1999
10:00 a.m. - 12:00 p.m.
White House
Old Executive Office Building, Room 180
Washington, DC**

- | | | |
|----|---|--------------|
| 1. | Welcome/Introductions | Dan Reicher |
| 2. | Overview of PATH Mission and Goals | Bill Apgar |
| 3. | Highlights of FY99 PATH Program Activities | |
| | a) PATH National Pilot Projects | Dan Reicher |
| | b) PATH Demonstration Projects | Dave Engel |
| | c) PATH Operating Plan | Larry Zarker |
| | d) Progress Report for Congress | Larry Zarker |
| 4. | How Agencies Should be Supporting PATH | Henry Kelly |
| 5. | Overview of HUD/PATH Program for FY1999 | Bill Apgar |
| 6. | The PATH Retrofit Goal in Coordination with the DOE
Weatherization Program and Other Agency Programs | Dan Reicher |
| 7. | Status of FY2000 Budget and FY2001 Agency Budget Strategies | Henry Kelly |
| 8. | PATH Office Staffing - Interagency Contributions | Bill Apgar |
| 9. | Next Steps/Adjourn | Dan Reicher |

Partnership for Advancing Technology in Housing (PATH)

Near Term Publicity Events

Revised: May 25, 1999

Sorted by Date

Project	Location	Dates	Description/Current Status
Armory Park del Sol	Tucson, AZ	Late June, 1999	The Armory Park del Sol project represents one of the first commitments to the new Million Homes initiative as part of the Livable Communities agenda in which a blighted infill site will be developed with highly energy efficient, affordable homes using labor in part from a non-profit program to provide skills based training for homeless people. Groundbreaking on this site is scheduled for late June, 1999 and the timing is flexible.
Heather Hills <i>Home of the Future</i>	Simi Valley, CA	June 28, 1999	A PATH demonstration project sponsored by Southern California Edison and built by Beazer Homes with technical assistance by HUD. The ribbon cutting for this house is scheduled for June 28, 1999. The house features a range of innovative "green" building technologies that provide a higher performance house while reducing the cost of owning and operating the house.
Pine Ridge PATH Blitz Build	Pine Ridge Reservation, SD	August 1999	PATH will provide technical support this summer to a major "blitz build" project on the Pine Ridge Reservation in South Dakota where 50 homes will be built in the space of one week in early August and a "technology showcase" will demonstrate advanced technologies for the 350 visiting tribal leaders from around the nation. Housing conditions on Native American reservations nationwide are substandard. Pine Ridge offers an opportunity to break this cycle by promoting ways for families not only to own their own home but to live in a house that is energy efficient, comfortable and durable.
Marketable, Affordable, Durable and Entry-Level (MADE) Houses	Bowie, MD	August 1999	A major planning and design process involving builders, architects, research professionals, manufactured housing providers, product manufacturers and HUD led to the development of a design for four houses in the NAHB National Research Home Park near Washington, DC that are marketable, affordable, durable and entry-level. Groundbreaking is scheduled for August.
21 st Century Townhouses in NAHB National Research Home Park	Bowie, MD	Available for Press Events Anytime. 30 Minutes from DC	Advanced housing technologies featured in the PATH program have been incorporated into a four unit townhouse project in the NAHB National Research Home Park in Bowie, MD. One of the houses features the first photovoltaic solar electric rooftop, in which the metal roofing for the house actually serves as the power plant for the home owners by converting sunlight into electricity. The solar electric rooftop blends in aesthetically with the other rooftops in the townhouse development. The HOMEBASE program is a communications infrastructure for the 200,000 companies involved in residential construction making it possible for them to learn more rapidly of the advances in technology that are becoming available.
Washington Square Seniors Townhouses	La Plata, MD	Early Fall, 1999	This is the opening of an 80-unit seniors townhome project in southern Maryland with promotional sponsorship from the Portland Cement Association. A range of innovative technologies – some of them concrete based – are featured in the units. The units are designed to require minimal utility bills, excellent indoor environment, acoustical isolation from nearby railroad tracks, resistance to high winds, and affordability.

Project	Location	Dates	Description/Current Status
PATH Advanced Wood Technology Demonstration House on the Mall	Washington, DC	Late 1999 or Spring 2000	The U.S. Forest Service, in conjunction with APA, The Engineered Wood Association and other participating PATH partners are planning to build a high-profile demonstration house on the Mall in Washington, DC in the fall. We expect extensive media coverage and large numbers of tours from the general public.
The International Builders Show and Exposition	Dallas, TX	January 2000	Over 70,000 builders, remodelers and product manufacturers attend the largest exposition of building products in North America each January. Advanced building products are demonstrated throughout the exposition and seminars demonstrate how to incorporate new technologies into their housing projects. This is the premier opportunity to address the 1700 member Board of Directors from around the country of the National Association of Home Builders.
The National Green Builders Conference	Denver, CO	April 2000	This is the first conference on resource-efficient construction for the mainstream home builder. It features leading-edge builders, developers, and practically minded building scientists focusing on the design, development, construction, marketing, and financing of homes that are environmentally-sensible and sought out by consumers. Over 450 builders attended in 1999.
Stapleton Airport Development	Denver, CO	September 2000	Stapleton Airport development is another National Pilot Project for the PATH program. Forest City Development was recently chosen as the developer of the site. It will be moving to land planning and building design in the coming year.
Playa Vista	Los Angeles, CA	September 2000	The press conference to announce the release of the Sustainable Development Guidelines for the Playa Vista project in Los Angeles was held on March 25. This is one of the five Presidential National Pilot sites for the PATH program. Over 500 homes in the first phase of sustainable development are scheduled to open at once in a major opening ceremony in September 2000.
Village Green	San Fernando Valley, CA	No new publicity events currently planned.	This is one of the PATH National Pilot site and is where President Clinton launched the PATH program on May 4, 1998. The Lee Group has now completed model homes for a ribbon cutting that was held on May 13. DOE A.S. Dan Reicher spoke at the event. Twenty production houses based on these advanced technology affordable model homes began construction in March.
Summerset	Pittsburgh, PA	No new publicity events currently planned.	A ground breaking ceremony was held for the Summerset National PATH Pilot Project on May 17 in Pittsburgh, PA. DOE A.S. Dan Reicher spoke at the event. Summerset is a "brownfields" site that will require environmental remediation in order to prepare the site for the sustainable development project within the city of Pittsburgh.
Civano	Tucson, AZ	Houses under Construction.	Civano is the large sustainable development project in Tucson that is one of the President's National Pilot sites for the PATH program. A community center and the models were included in a ribbon cutting ceremony in April 1999.

PATH Coordinating Council Working Groups

Three meetings were held in 1998 of the PATH Coordinating Council. Approximately 60 people attended these meetings in Washington, DC to learn what the program planned to accomplish in the coming year. Since the meeting in November 1998, there has been support expressed from the building industry participants (builders, remodelers, and manufacturers) and the federal agencies to split the Coordinating Council into working groups that can address specific issues vital to the program's success. We will dispense for now with day-long meetings in Washington of the full Coordinating Council. Five topics have been selected as working group subject areas. They are: technology roadmapping, finance, barriers/insurance, quality and labor issues, and consumer education and expectations.

Management of the Working Groups

The working groups will be co-chaired by industry and federal representatives. The agenda for each of the first working group meetings will be set by the industry and agency leads; subsequent meeting agendas will be set by the participants in the task groups. Most meetings will take place by conference call on a bi-weekly or monthly basis as determined by each of the working groups. Occasional face-to-face meetings may be scheduled.

The purpose of the working groups is to identify key issues that need to be resolved in order accelerate the successful achievement of PATH program goals. The working groups will discuss issues relating to the PATH FY99 Operating Plan and the Action Plan that is currently under development. Proposed working groups are described below:

Finance

One of the challenges confronting the introduction of new technologies is that they often cost more at product introduction than the products they compete with. This means that introduction often occurs at the upper end of the housing market. The result is that those who most need the advantages of lower operating costs, maintenance and repair costs offered by new technologies are least able to afford them. Even without increased first costs, some families need help with down payments. How can PATH create financing incentives that will enable the introduction of innovative technologies across the full spectrum of housing, including especially low and moderate income housing where the value created by the technology will be recognized? Routine underwriting practices that provide higher income to debt ratios for PATH houses will help more households purchase such homes. How can the lower insurance, operating, and maintenance costs of PATH homes be taken into account in underwriting home purchase or rehabilitation loans? How can the value of PATH technologies be

accurately reflected in appraisals? This task group will investigate innovative approaches toward financing advanced housing technology.

Technology Roadmapping

The PATH goals set an ambitiously high standard for housing performance by the year 2010. Not only do we expect to make homes more energy and environmentally efficient, more durable, and disaster resistant, but we also expect them to cost less to own and operate. Technology roadmapping will enable the residential building industry and the agencies whose missions relate to the industry to identify pressing needs for technology development. Some of this work has already been done through the three year process that led to the publication of the report, *Building Better Homes at Lower Costs: The Industry Implementation Plan for the Residential National Construction Goals*. Other sources of useful information are the 15,000 calls on problems and technical issues in housing that have been logged into the HOMEBASE Hotline database as well as responses to the NAHB Research Center's Annual Consumer Practices survey which compiles information on repair and remodeling practices. What is lacking, however, is a formal roadmapping process that establishes technology priorities that will guide funding and R&D decisions. This working group will create a technology roadmap for the PATH program on technologies needed to help achieve the PATH goals.

Barriers/Insurance

One of the major barriers to the introduction of new and innovative products into the home building industry is the fear of liability from the failure of the product. Home building presents some unique circumstances which justify developing a special program to address this issue. There is a need for a program that will permit builders' insurance companies to fully cover all risk inherent in the deployment of new technologies at a reasonable rate to the builder; and, a program that will reassure builders that the manufacturer will be there to honor the warranty. Another insurance issue is property insurance. Many PATH technologies can reduce risks of damage under natural disasters. How can the insurance industry factor in these technologies in setting rates and provide incentives for PATH technologies?

Quality and Labor Issues

Methods of quality improvement have dramatically changed the way in which many construction companies conduct their business in recent years. Borrowing from the successful introduction of quality concepts in other industries, residential construction companies are providing better value to their customers and improving their net income in the process. The residential industry now has two awards which recognize company efforts to deliver highest levels of quality. They are the National Housing Quality Award and the National Remodeling Quality Award modeled after the prestigious Malcolm Baldrige Award. How can PATH take the message of the successes of these few award winning firms to

the broader context of the 60,000 firms who are building and remodeling the nation's housing? At the same time the housing industry is facing a crisis in the availability of skilled labor to deliver a quality product. This task group will address programs of skills development and on-the-job training that will enable the work force to accept innovative technologies and install them correctly.

Consumer Education and Expectations

Builders often state that they would be more willing to incorporate innovative technologies into their houses or remodeling projects if their customers ask for them. The industry spends billions of dollars annually trying to deliver their messages to consumers. Consumer awareness about new technologies is often influenced by the messages delivered through product advertising. Consumers often don't understand the full costs of a new product or its performance when installed in a house. The PATH program will be developing a comprehensive set of technical information on the performance and expected costs of new technologies. PATH is not trying to sell products to consumers; instead, it will be focusing on raising consumer awareness of technologies that can deliver higher performing houses that are less expensive to own and operate. This task group will explore ways in which the government and industry can deliver the messages of PATH to the consumer and help them understand how to ask for PATH technologies.



Questions and Answers about the Partnership for Advancing Technology in Housing

Q. What is the Partnership for Advancing Technology in Housing?

The Partnership for Advancing Technology in Housing is a public/private initiative which seeks to speed the creation and widespread use of advanced technologies in order to radically improve the quality, durability, energy efficiency, environmental performance and affordability of our Nation's housing.

PATH is a voluntary partnership in which leaders of the home building, product manufacturing, insurance and financial industries join forces with representatives of federal agencies concerned with housing. By working together, PATH partners improve the quality and affordability of today's new and existing homes; strengthen the technology infrastructure of the United States and help create the next generation of American housing.

The PATH program spurs housing industry design and construction change by providing the latest information on innovative building materials, processes and systems; showcasing innovative housing projects that can serve as models for builders and homeowners across the country; promoting focused, cooperative housing research among industry, government and university partners; and tackling institutional barriers to innovation – from risk and liability concerns to the lack of effective product evaluation systems.

Q. What are PATH'S goals?

During the next decade the partnership will encourage the development of innovative housing components, designs and production methods and reduce by 50 percent the time needed to move quality technologies to market. These technologies will make it possible to produce housing that is affordable and attractive. At the same time, these new technologies will by 2010:

- reduce the monthly cost of new housing by 20 percent or more;
- cut the environmental impact and energy use of new housing by 50 percent or more and reduce energy use in at least 15 million existing homes by 30 percent or more;

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www.pathnet.org

- improve durability and reduce maintenance costs by 50 percent; and
- reduce by at least 10 percent the risk of loss of life, injury and property destruction from natural hazards and decrease by at least 20 percent work-related illnesses and injuries in residential construction.

Q. What does that mean in “real-life” terms ?

PATH will change the way Americans live. Expected results from the PATH effort are increased housing affordability; increased durability; lower construction costs; improved energy efficiency; fewer construction injuries; less disaster losses; and accelerated development and increased market acceptance of new housing technologies. The technology development and utilization process, itself, will also insure that the American housing and construction industry will be a dynamic economic force far into the 21st Century.

It will also mean more money in the pockets of the average American homeowner. For instance, the average American household spends \$940 a year on home maintenance and repairs and improvements. A 50 percent savings in residential maintenance costs means \$470 a year more in the homeowner's pocket or \$39 more a month.

In addition, the average new house energy bill is \$1,500 a year. A 50 percent cut in the average new house energy bill reduces that annual cost to \$750. Monthly savings for the home owner will be \$62.50. Approximately 200,000 new homes are built each year. Multiplying the \$750 savings per home by 200,000 results in \$150 million dollars saved in energy costs each year.

A 50 percent cut of the average \$1,500 energy bill of 15 million existing homes will save the consumer/homeowner approximately \$450 a year or \$14,000 during the life of a 30 year mortgage. Monthly savings for those home owners will be \$37.50. The total annual energy savings in dollars for 15 million existing homes (\$450 X 15 million) is \$6,750 billion a year savings.

By the year 2010, PATH technologies will save consumers \$18 billion a year in energy costs and reduce annual carbon emissions by 39 million tons, equivalent to the amount produced each year by more than 30 million cars.

Q. Briefly how is PATH going to achieve those objectives?

PATH offers technical assistance to individual builders and remodelers who are willing to evaluate specific promising innovative technologies in their housing. Manufacturers participating in the PATH initiative can ask for feedback on changes needed to improve their products' ability to meet PATH goals.

PATH promotes the general use of new housing technologies through pilot projects and demonstration programs with builders across the country. Currently it is working with builders and city officials in Denver, Los Angeles, Pittsburgh, and Tucson interested in incorporating appropriate technologies in local housing developments and it is looking for additional sites.

PATH's website (www.pathnet.org) serves as an Internet gateway to the latest housing information – offering links to housing industry technical resources; descriptions of federal housing programs; and news of housing technology advances made by private and public sector partners. With the NAHB Research Center HOMEBASE Online, PATH also offers in-depth descriptions of more than 132 innovative materials, products and systems considered to have less than five percent of their potential market share. PATH also promotes and spotlights with HOMEBASE case histories of field applications of new housing technologies.

PATH tackles institutional barriers to the acceptance of innovation such as liability concerns, the lack of a clear national system for the evaluation of new products and systems, the prescriptive nature of codes and local code approvals, regulatory confusion, inadequate training, and risk aversion. With experts, PATH develops strategies for overcoming these roadblocks to progress.

PATH promotes focused, cooperative housing research among industry, government and university and national laboratory partners. The partnership promotes commercializing federal research and development.

Q. Who are PATH's Partners?

The federal agencies in PATH include the Departments of Agriculture, Commerce, Defense, Energy, Housing and Urban Development, Labor, and Transportation, and the Environmental Protection Agency, the Federal Emergency Management Agency, the National Science Foundation, and the White House Office of Science and Technology Policy. The Department of Housing and Urban Development administers the PATH secretariat.

Private sector members of PATH include representatives of builders, remodelers and developers; housing manufacturers; product manufacturers; financial and insurance organizations; distributors and retailers; university and research laboratories; utilities and labor organizations.

PATH is a low-cost/high-leverage technology partnership. The government's primary role is to act as catalyst, facilitator, and "remover of barriers." The industry itself will develop and deploy the technologies for the next generation of American housing.

Q. How is PATH managed?

The PATH program is managed by the Department of Housing and Urban Development (HUD). Day-to-day management of the program is provided by a Director and his/her staff. The Director reports to the Assistant Secretary for Housing/FHA Commissioner. Leadership of the overall policy direction for PATH is provided jointly by HUD and the Department of Energy, in cooperation with the PATH Interagency Council (PIC), composed of senior representatives from DOE, HUD, EPA, FEMA, NIST and USDA. The PATH Director serves as executive secretariat to the PIC. The PIC meets quarterly. The purpose of the PIC is to provide federal policy guidance; to monitor progress of PATH projects, including individual agency contributions to PATH; and to identify targets of opportunity for principals.

In addition to the PIC, a federal agency working group -- comprising representatives of all the federal agencies participating in PATH -- facilitates day-to-day coordination of federal activities pertaining to the program. The working group supports the PIC in developing policy guidance for PATH; identifies individual agency contributions to PATH; establishes federal agency technical assistance teams for specific PATH projects; and promotes PATH goals and initiatives within individual agencies. The federal agency working group meet monthly and functions as a task force of the Construction and Building Subcommittee of the National Science and Technology Council, under the overall direction of the PATH Director.

A PATH Coordinating Council (PCC) -- made up of representatives from the home building, product manufacturing, insurance and financial industries in cooperation with PATH's federal agency partners -- provides general guidance to PATH management. The PCC meets three times per year, with at least one of the meetings organized for and attended by senior principals from the participating organizations. The purpose of the PCC is to provide private sector input to PATH programs, to participate in PATH initiatives and to stimulate industry to address PATH goals.

In conformance with Congressional direction, PATH developed a full operational plan, including specific and measurable goals. A draft evaluation report is due to Congress in April, 1999.

Q. What commitment do PATH Partners make to each other?

PATH Partners agree to

- make a good faith effort to offer housing products that meet PATH goals in large markets by 2010;
- participate in the joint management of partnership;
- share non-proprietary information about the costs, benefits and other characteristics of building innovations with the partnership; and
- work with appropriate federal and state agencies to develop and implement tests of innovative products and systems.

Q. How are the Federal Partners contributing to the PATH effort?

PATH's federal partners contribute toward all the goals. For instance, the Department of Energy's Building America Program and the Environmental Protection Agency's Energy Star Homes Program play a key role in advancing a multiple of environmental and energy efficiency technologies. The Department of Housing and Urban Development is also active in the identification of high-priority technologies as well as field demonstrations of the technologies. The Department of Commerce's National Institute of Standards and Technology has expertise in advanced insulation measurement, residential fire safety research, advanced building materials as well as codes and standards issues. The Department of Agriculture Forest Products Laboratory provides expertise in engineered wood issues. The Federal Emergency Management Agency and the Department of Labor are interested in everything from the construction of tornado safe room shelters in homes to worker training.

Federal partners detail special personnel to the PATH campaign who coordinate programs and work together with the private sector to develop, demonstrate and deploy advance technologies that will improve the quality and affordability of today's new and existing homes; strengthen the technology infrastructure of the United States and help create the next generation of American housing.

Q. Why is PATH necessary? Can't private industry "advance technology" on its own?

No, not by itself. Despite the importance of the housing industry, expenditures on residential technology research and development is relatively low as a percentage of sales compared to other industries and in comparison to other industrialized countries.

Emerging technologies that could be useful to the housing industry are also all too often not readily accepted. This is because housing, unlike other major engines of the economy, is extremely dispersed consisting of hundreds of

thousands of separate companies. To introduce a new technology into this marketplace, let alone achieve any significant market penetration, is a time consuming and costly process – one which discourages most attempts at true innovation and slows down those that do get past the prototype stage. It can take 10 to 25 years for a new housing product or technique to achieve full market penetration.

PATH concentrates on gaps; those areas where technology – as a result of regulatory barriers, lack of information, or inadequate technical support – is failing to reach the marketplace. By helping industry close these gaps, and get next generation technology into the market faster, the PATH will have a significant impact on improving the quality and affordability of U.S. housing.

Q. How did PATH originate?

The residential building industry is one of the largest and most important sectors of the U.S. economy. In recognition of the role of housing in the U.S. economy, the White House in 1994 convened representatives from all segments of the nation's construction industry to consider a broad set of National Construction Goals. Over the next three years the residential segment of the construction industry – represented by home builders, code officials, product manufacturers and other interested parties – developed a research plan for implementing National Construction Goals for the housing sector. PATH is the outgrowth of those proposals.

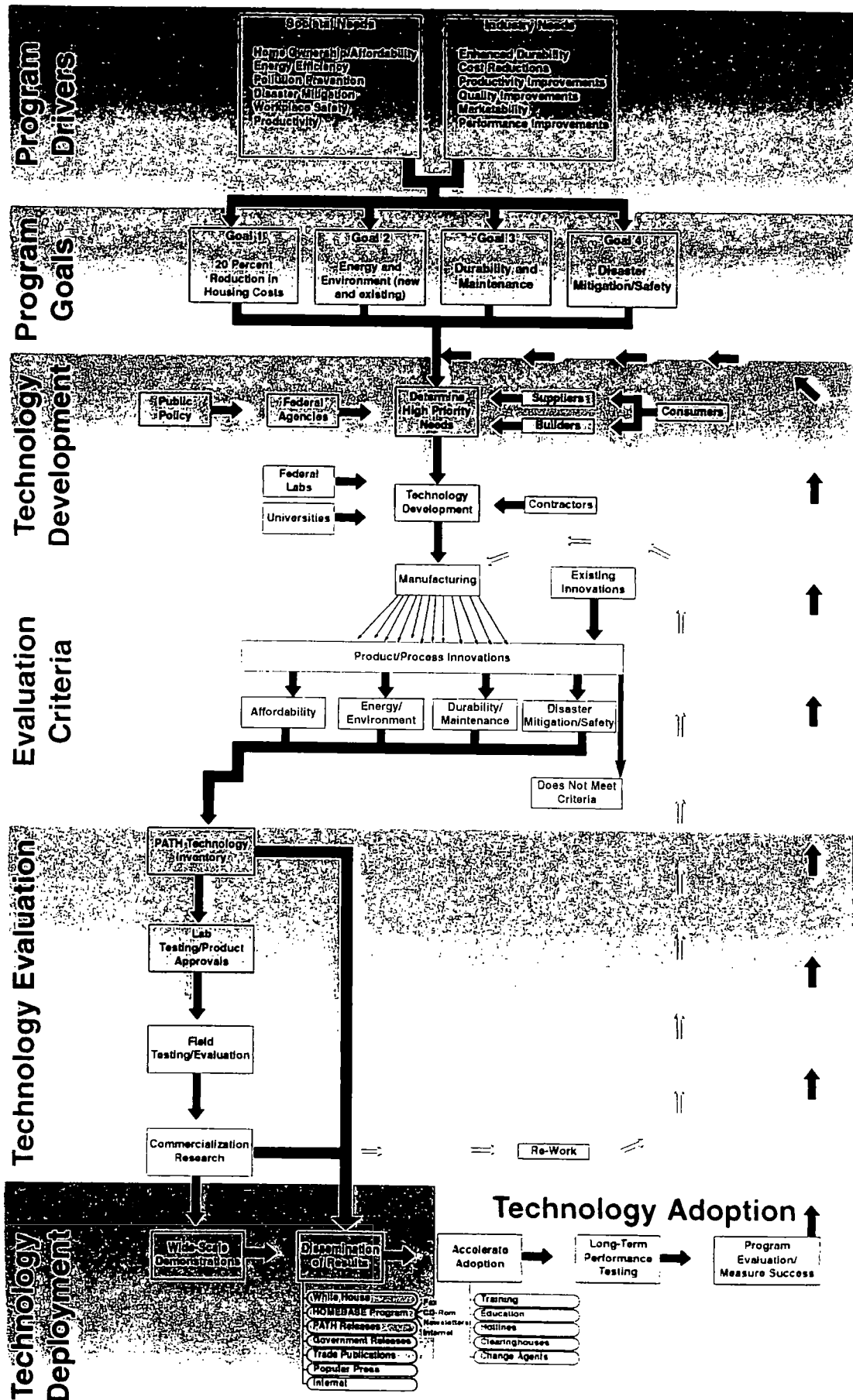
President Bill Clinton officially launched the Partnership for Advancing Technology in Housing (PATH) May 4, 1998 in Los Angeles, California during ground-breaking ceremonies for 186 energy-efficient, moderately priced homes in the San Fernando Valley. The President described PATH as “the most ambitious effort ever to help private home builders and home owners make cost-effective, energy saving decisions that will pay big dividends throughout the 21st century.”

In an address last May to the National Association of Home Builders Spring Board meeting, Vice President Al Gore said, “ By working together, we’re going to bring America homes that are safer, more affordable, more durable, more energy efficient, more comfortable. And we’re going to do it through the power of the marketplace.”

Q. How can one learn more about PATH?

For further information about PATH contact: John G. Blair, PATH, Director of Communications; Suite B133, 451 Seventh Street, SW, Washington, DC 20410 Telephone (202) 708-4277, Extension 106 / E-mail: jblair@pathnet.org.

PATH Program Plan





Contact; John G. Blair
(202) 708-4277

For Immediate Release
January 15, 1999

Technology Partnership Seeks 21st Century Builders

Builders, remodelers and manufacturers – Do you have a new, different and potentially breakthrough housing or construction idea? The Partnership for Advancing Technology in Housing (PATH) wants to hear from you!

PATH, which unites hundreds of leaders from the home building, product manufacturing, insurance and financial industries with representatives from federal agencies concerned about housing issues, is also on the lookout for people and organizations that want hands-on experience with new housing technologies, products and systems.

The partnership, launched last May in Los Angeles by President Clinton, works to spur design and construction innovations for the next generation of American homes. Its goal is to speed the creation and widespread use of advanced technologies to radically improve the quality, durability, energy efficiency, environmental performance and affordability of U.S. housing.

“For builders, remodelers and manufacturers PATH is a win-win proposition. It spotlights emerging technologies we can use, brings needed products to market faster and showcases outstanding building examples for us all,” said Don Martin, 1998 NAHB president who shared the podium with President Clinton at the PATH launch.

PATH offers technical assistance to individual builders and remodelers who are willing to evaluate promising innovative technologies in their housing. Manufacturers participating in the PATH initiative can ask for feedback on changes needed to improve their products' ability to meet PATH goals.

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Technology Making a Difference Where Americans Live

PATH promotes the general use of new housing technologies through pilot projects and demonstration programs with builders across the country. Currently it is working with builders and city officials in Denver, Los Angeles, Pittsburgh, and Tucson interested in incorporating appropriate technologies in local housing developments and it is looking for additional sites.

In addition to providing builders and manufacturers with the latest information on innovative building materials, products and systems, PATH coordinates focused, cooperative housing research among industry, government and university partners. In 1999 PATH intends to sponsor a Conference on the Future of the House to help shape the national housing research and development agenda.

PATH partners are also tackling institutional barriers to the acceptance of innovation – from risk and liability concerns to the lack of effective product evaluation systems, the prescriptive nature of codes and local code approvals, regulatory confusion, and inadequate training.

Congress, which appropriated \$10 million for PATH programs in fiscal year 1999 expects the initiative, by 2010, to (1) reduce the monthly cost of new housing by 20 percent or more; (2) cut the environmental impact and energy use of new housing by 50 percent or more and reduce energy use in at least 15 million existing homes by 30 percent or more; (3) improve durability and reduce maintenance costs by 50 percent; and (4) reduce by at least 10 percent the risk of loss of life, injury and property destruction from natural hazards and decrease by at least 20 percent work illnesses and injuries in residential construction.

PATH private and public sector partners direct the initiative through their commitment of time, resources and leadership. PATH partners agree to make a good faith effort to offer housing products that meet PATH goals in large markets by 2010; participate in the joint management of the partnership; share non-proprietary information about the costs, benefits and other characteristics of building innovations with the partnership; and work with appropriate federal and state agencies to develop and implement tests of innovative products and systems.

Private sector partners include representatives of builders, remodelers and developers; housing manufacturers; product manufacturers; financial and insurance organizations; distributors and retailers; university and research laboratories; utilities and labor organizations.

Public sector partners include the U.S. Departments of Agriculture, Commerce, Defense, Energy, Housing and Urban Development, Labor and Transportation, the Environmental Protection Agency, the Federal Emergency Management Agency, the National Science Foundation, and the White House Office of Science and Technology Policy. The Department of Housing and Urban Development administers the PATH secretariat.

The NAHB Research Center is helping PATH communicate technical results of the program to the building industry through its HOMEBASE program. For more information on PATH and how to join the partnership call the HOMEBASE hotline at 1-800-898-2842 or visit HOMEBASE ONLINE at www.nahbrc.org/homebase.

The PATH website is www.pathnet.org. It serves as an Internet gateway to the latest housing information – offering links to housing industry technical resources; descriptions of federal housing programs; and news of housing technology advances made by private and public sector partners.

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Housing Web Site Offers Access to New Technology

A one stop Internet site for the latest housing technology news set up shop this January in Cyberspace. Its address is **www.pathnet.org** and it's the home of the Partnership for Advancing Technology in Housing (PATH), a public/private sector White House initiative established last May to speed the creation and wide-spread use of advanced technologies in the housing and construction industry.

PATH, which President Clinton has called "the most ambitious effort ever to help private home builders and home owners make cost-effective, energy saving decisions," brings together key federal agencies, concerned with housing, with leaders from the home building, product manufacturing, insurance and financial industries. PATH partners aim to expand use of advanced technologies to radically improve the quality, durability, environmental performance, energy efficiency and affordability of the nation's homes.

"We intend to build **www.pathnet.org** into a national focal point for people interested in acquiring and using innovative housing technologies," said John Blair, PATH communications director. "The PATH web site complements our more traditional programs – demonstrations and pilot projects, focused conferences and seminars, efforts to commercialize federal R&D. In fact, the web site should make all those efforts all the more effective because it allows us to send the results out faster," he said.

The PATH web site's serves as an Internet gateway to the latest housing information – offering links to housing industry technical resources; descriptions of federal housing programs; and news of housing technology advances made by private and public sector partners.

In conjunction with the NAHB Research Center website, HOMEBASE Online at **www.nahbrc.org/homebase**, PATH also offers in-depth descriptions of more than 120 innovative materials, products and systems considered to have less than five percent of their potential market share.

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Technology Making a Difference Where Americans Live

The online entries cover such items as: aerosol duct sealing; dimmable fluorescent lighting fixtures; electrochromatic windows; energy-efficient interior storm windows; geothermal heat pumps; insulating concrete forms; photovoltaic (PV) roofing; prefabricated storm shelter; recycled wood flooring; thermochromic window film; tilt-up roofs for manufactured and modular homes; ventilation control systems; and xeriscaping.

PATH's technology entries includes photographs, drawings, installation details, examination of benefits, costs and limitations, code and regulatory related news and a list of contacts.

The PATH web site also promotes and spotlights with HOMEBASE, case histories of outstanding housing projects throughout the U.S. where innovative technologies are being installed and used. The data base covers a range of projects, from individual homes to entire subdivisions, that are pushing the state-of-the-art in design and construction innovation. Information is presented from the viewpoint of builders and remodelers who can use these examples as models for projects of their own.

The projects and builders currently featured on the web site are as follows: AFM Study House in Minneapolis, MN by the AFM Corporation; Environmental Showcase Home in Phoenix, AZ by Arizona Public Service; FBC Infill Housing in Louisville, KY by FBC; Greenlee Park in Boulder, CO. by McStain Enterprises, Inc.; The Grove at Patuxent Woods in Patuxent City, MD by the Southern Maryland Tri-County Community Action Committee, Inc.; Healing House in Dallas, TX by BBH Enterprises, Inc.; Hillside Oaks in Dallas, TX by Carl Franklin Homes Inc.; Lido Homes in Newport Beach, CA by Silvercrest Western Homes; New Colony Village in Jessup, MD by Corridor 1 L.P; Palm Harbor Homes in Dallas, TX by Palm Harbor Homes; Solar Townhouses in Philadelphia, PA by Bradley Builders; and West of Pennsylvania in Brooklyn, NY by the East Brooklyn Congregation.

The PATH web site lists federal government housing programs and web sites, submitted by the federal partners. PATH's federal partners include the Departments of Agriculture, Commerce, Defense, Energy, Housing and Urban Development, Labor, and Transportation, the Federal Emergency Management Agency, the National Science Foundation, and the White House Office of Science and Technology Policy.

The Department of Housing and Urban Development and the Department of Energy provide federal policy direction to the PATH program. The Department of Housing and Urban Development administers the daily operation of the program. ##