Shortly after the discovery of an oil and gas field, an initial estimate is usually made of the ultimate recovery of the field. With the passage of time, this initial estimate is almost always revised upward. The phenomenon of the growth of the expected ultimate recovery of a field, which is known as “field growth,” is important to resource assessment analysts for several reasons. First, field growth is the source of a large part of future additions to the inventory of proved reserves of crude oil and natural gas in most petroliferous areas of the world. Second, field growth introduces a large negative bias in the forecast of the future rates of discovery of oil and gas fields made by discovery process models. In this study, the growth in estimated ultimate recovery of oil and gas in fields made up of sandstone reservoirs formed in a complex depositional environment (Frio strand plain exploration play) is examined. The results presented here show how the growth of oil and gas fields is tied directly to the architectural element of the shoreline processes and tectonics that caused the deposition of the individual sand bodies hosting the producible hydrocarbon.

Key words:
Petroleum resource assessment
Discovery rate models
Field growth
Frio depositional system
**Introduction**

Field growth, the growth of the expected ultimate recovery of a field, was first recognized as an important phenomenon in oil and gas resource assessment by Arrington (1960). Since then, many resource assessment analysts have studied field growth and have implemented analytic devices to compensate for the effects of field growth, which, when ignored, can introduce large negative biases into the assessment of the undiscovered oil and gas resources of a region (Hubbert, 1967, 1974; Marsh, 1971; Pelto, 1973; Mast and Dingler, 1975; White and others, 1975; Root, 1982; Manger and others, 1985; Drew and Lore, 1992; Drew and Schuenemeyer, 1992; Root and Mast, 1993; Schuenemeyer and Drew, 1993). Oil and gas fields grow over time by expansion of existing reservoirs, discovery of additional reservoirs, and upward revision of previously made estimates of the ultimate recovery of a reservoir(s).

Much of the concern over field growth has arisen from the biases introduced into the assessment of the volumes of oil and gas that remain to be discovered. In the 1960's, studies showed that these biases affected the assessment of aggregate volumes of undiscovered oil and gas for the United States (Hubbert, 1967, 1974). More recently, field growth has been identified as a bias in the estimation of the undiscovered size distribution of the oil and gas fields via discovery process models in partially explored plays (Manger and others, 1985; Drew and Schuenemeyer, 1990a, 1990b, 1992; Drew and others, 1993; Schuenemeyer and Drew, 1993).

Marsh (1971) and White and others (1975) recognized that long periods of field growth typically are associated with oil and gas fields that comprise reservoirs deposited in complex depositional environments and (or) modified by growth faulting and salt tectonics. White and others (1975) also cited incomplete and faulty recordkeeping and the inherently difficult task of estimating oil and gas reserves in a reservoir as additional complexities in analytically determining functions that describe the field growth process over time. One of the intriguing features identified in this investigation is that the estimated ultimate recovery of very old oil and gas fields can suddenly and dramatically increase. This had been noticed by White and others (1975) in their analysis of the growth of aggregate packages of natural gas in fields discovered before 1953 in onshore southern Louisiana.

In more recent studies, field growth has been shown to cause a significant underestimation of future rates of discovery of oil and gas fields made by using discovery process models in partially explored regions, such as the Gulf of Mexico. This underestimation is severe and can occur over short periods of time (Drew and Schuenemeyer, 1990a, 1990b, 1992; Drew and Lore, 1992).

The purpose of this study was to investigate how oil and gas fields have grown by the addition of reservoirs hosted in a complex depositional environment. The growth of the estimated ultimate recovery at the field level through successive reservoir discovery and development and through revisions processes has not been easy to examine because sequential estimates of field size (yearly estimates of the ultimate recovery of individual oil and gas fields) have not been available until recently. Unfortunately, these data are proprietary, and, therefore, not generally available to the public. These data comprise the Field and Reservoir Reserve Estimates File (FRRE), which is maintained by the U.S. Minerals Management Service for offshore fields, and the Oil and Gas Inventory Field File (OGIFF), which is maintained by the (EIA). A publicly available field and reservoir file maintained by NRG Associates Inc. contains field-level ultimate recovery data for U.S. fields larger than 1 million barrels of oil equivalent for the period 1982–90. The quality of the data in this nonproprietary file has improved in the last several years with the expanded coverage of much reservoir-level data for the fields in the United States.

However, yearly and cumulative production data have been published in book form for most of the oil and gas fields in the United States by the International Oil Scouts Association (1992). Estimates of the ultimate recovery of fields can be made for this type of data by using a reserves-to-production rate multiplier. The ultimate recovery estimates produced by this method can, in turn, be used to study the temporal pattern of field growth.

In this study we used data for the Frio Strandplain exploration play. The fields comprise reservoirs in a barrier island/strandplain facies of the Frio clastic wedge of Miocene/Oligocene age in the Texas gulf coast (fig. 1). The larger fields in this exploration play often contain over 100 reservoirs. Many of these fields were discovered during the 1920's and 1930's and have been developed on a nearly continuous basis. A variety of factors affect field growth (table 1). Two of these factors, physical expansion and field merger, will be examined here. The growth of the fields in the study areas during the 1970's and early 1980's by addition of reservoirs that predominantly contain natural gas also is examined.

**Approach Used In This Study**

Field growth is studied by examining the temporal and spatial order of discovery of the reservoirs that comprise a field. The pattern of growth in the ultimate recovery of a field is examined in light of the spatial discovery and growth of the reservoirs. Only data from 1991, which is