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The Composition and Distribution of the Fish Fauna of the Navasota River

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Texas Water Resources Institute

Texas A&M University

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THE COMPOSITION AND DISTRIBUTION OF THE FISH FAUNA OF THE NAVASOTA RIVER

Principal Investigators

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Proposed water development projects for the Navasota River include the construction of dams. If these dams are constructed, changes in the fish populations are sure to occur. This study should contribute basic information from which the effects of future water development can be evaluated.

ABSTRACT

The Composition and Distribution of the Fish Fauna of the Navasota River

Edward R. Rozenburg, R. Kirk Strawn, and William J. Clark

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Twenty-one thousand fish representing 9 orders, 14 families, and 56 species were collected from various habitats of the Navasota River drainage. Some species such as Notropis lutrensis, Gambusia affinis and Lepomis macrochirus were taken throughout the drainage from widely varying habitats. Others, such as Notropis atrocaudalis, N. venustus and Campostoma anomalum, were found only a few times in more specialized habitats.

Some Austroriparian species, such as Fundulus notti, F. olivaceous and Lepomis marginatus, apparently reach their western range limits at or near the Navasota drainage. Other east Texas and coastal plains fishes such as Amia calva and Lepomis symmetricus reach their western inland limits at or near the Navasota drainage.

Some species, such as Dionda episcopa, Hybognathus placitus, and Etheostoma spectabile, are found in more western drainages but are absent from the Navasota drainage.

It is suggested that some of these fish distributions are the result of immigration or stream piracy.

Proposed water development projects for the Navasota River include the construction of dams. If these dams are constructed, changes in the fish populations are sure to occur. This study should contribute basic information from which the effects of future water development can be evaluated.

ACKNOWLEDGEMENTS

Thanks are due to Mr. Van Conner of the Wildlife and Fisheries Sciences Department, Texas A&M University and Dr. Glenn Clemmer of the Zoology Department, Mississippi State University for help with fish identification, and to Dr. Robert Martin for making the fish collection of the Texas Natural History Collection available for study.

The help of Mike Dewey, Scott Holt, James Steele, and Ed Guidry on the collection team is gratefully acknowledged.

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INTRODUCTION

Reasons for Study

The Navasota River has been little affected by impoundments. There are no impoundments on the main channel south of Lake Springfield in Fort Parker State Park near Groesbeck, and few of the tributaries are dammed. Funds are being sought by the U. S. Army Corps of Engineers to construct dams at river mile 24.1 and 83.4. Construction of dams is known to result in considerable change in the fish fauna of a river system (Keith, 1964), but few fish surveys have been conducted to determine the extent of these changes. This study was made to provide a record of the distribution and relative abundance of the fishes in the Navasota River. Proposed water development projects, if implemented, are certain to cause changes in the biota of the Navasota River system. This study will provide the basis for studying the effects of environmental changes on the fish fauna of the Navasota River system, and will help in understanding the effects of water development projects on the fishes of Texas.

Review of Literature

Data on the fish fauna of the Navasota River are c

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Brazos drainage, because of its eastern

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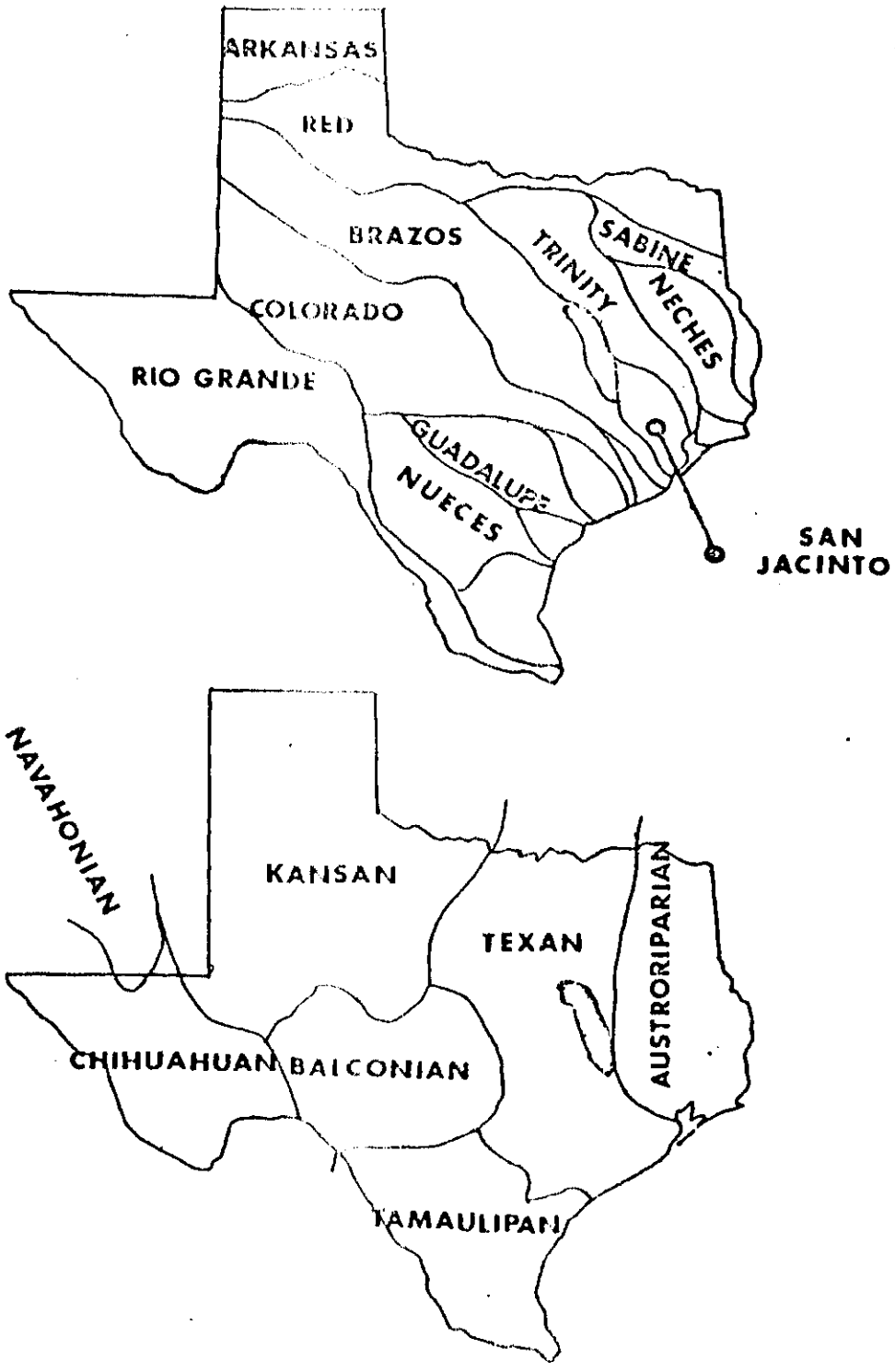
son (1967) used Fundulus olivaceus from the Navasota drainage in his biosystematic study of Fundulus notatus and Fundulus olivaceous.

Description of the Study Area

The Navasota River, one of the larger tributaries of the Brazos River enters the Brazos about 232 river miles from the Gulf of Mexico (Figure 1). According to the U. S. Corps of Engineers, the Navasota River has a total drop from source to mouth of 507 feet, drains 2500 square miles, and is 195 river miles long (Anon., 1950). The Navasota arises about 1.5 miles northeast of Mount Calm in Hill County and flows southeast through Limestone County, serves as the boundary between Robertson and Leon Counties and separates Brazos County from Madison and Grimes Counties. A small part of Freestone County is also in the drainage.

According to the vegetation map of Kuchler (1964), the headwaters drain part of the Blackland Prairie Region. The rest of the channel flows across the Oak-Hickory Region with the mouth in the Fayette Prairie. A small part of the Southeastern drainage is located in the mixed Pine-Oak-Hickory Region.

The various oaks (Quercus) and yaupon (Ilex vomitoria) were prevalent in the study area. In places along the river and creek bottoms, hickories (Carya) and willows (Salix) were present. Smilax and yaupon often formed a dense understory. Lake Normangee in Leon County and Camp Creek Lake in Robertson County were so choked with pondweed (Elodea canadensis) that it was almost impossible to use a


ARKANSAS
RED
BRAZOS
TRINITY
SABINE
NECHES
COLORADO
RIO GRANDE
GUADALUPE
NUECES
SAN JACINTO
NAVAHONIAN
KANSAN
TEXAN
AUSTRORIPARIAN
CHIHUAHUAN
BALCONIAN
TAMAULIPAN

seine or a gill net.

Horsetail (Equisetum) was often found along sand bottom streams in the southern part of the drainage. Ferns were common in some damp areas, usually along creek banks or on trees. Masses of filamentous green algae were common in stationary water April to June, 1968.

Organic pollution downstream from the sewage outflow of Mexia in Plummer's Creek, Freestone County, was indicated by a bad odor and a dense plankton bloom.

The watershed is within the Texan biotic province (Figure 2), with the Texan-Austroriparian boundary close-by on the east, (Blair, 1950).

The soils along the river are dark colored and are of the Houston, Lufkin, Edge, and Tabor series (Anon., 1960). The average rainfall varies from about 41.30 inches annually in the eastern part of the drainage (Madison Co.) to 35.80 inches annually in the western part of the drainage (Robertson Co.) (Anon., 1968).

Agriculture

Over 75% of the current agricultural output of the area is from beef cattle, dairy products, and poultry. Cotton is on the decline in the Navasota River drainage area. Only in Brazos, Robertson, and Hill Counties was the 1966 cotton output greater than that in 1940. Only Hill and Limestone Counties showed an increase in cotton production from 1965 to 1966. This appears to be following a statewide trend away from a single crop to a more diversified agriculture and

to increased use of land for pasture. There is also a trend away from smaller, private farms to larger, more commercial establishments (Anon., 1968).

METHODS AND MATERIALS

The drainage was divided into three north to south divisions, for both collection purposes and discussion of fish distribution. The lower boundary for the upper division was defined as the Limestone-Robertson County and Freestone-Leon County lines. The lower boundary for the middle division was defined as the Old San Antonio Road (OSR), which forms the boundary between Brazos and Robertson and Madison and Leon Counties. Attempts were made to collect each division in sequence every third collection trip. The drainage was also divided into four sections from east to west, (east tributaries, channel, floodplain, west tributaries) for discussion purposes.

Each tributary used in the study was divided into thirds, and a gradient was calculated for each third. Length in miles and change in elevation in feet between start and end of each third were measured from a U. S. Geological Survey topographical map. Change in elevation was divided by the length of the section to get the gradient in feet-per-mile.

Except for temperature, all chemical and physical data used were collected by co-workers on other parts of this study or by the U. S. Geological Survey at its metering stations along the river.

Fish collections were made with seines, gill nets, and once with hoop nets. The use of electro-fishing gear would have improved collecting efficiency, especially in the snag-filled, small streams prevalent throughout the drainage, but permission for its use could

not be obtained.

Straight seines were the primary method used for collection. Three sizes of straight seines were used.

A nylon seine 4 by 4 ft of 1/16 inch ace mesh was used in smaller streams which usually had sand and/or gravel bottoms. It was effective in netting fish from beneath log jams and tree roots. The seine would be placed beneath the obstacle or as close to it as possible and the obstacle was agitated, creating a disturbance and chasing the fish from the shelter of the obstacle into the net. This seine was also set across riffles and fishes were driven into the net by disturbing the bottom and agitating the water. The latter method was useful for collecting many species, especially Campostoma anomalum, Notropis atrocaudalis and several species of darters.

The most frequently used seines were 6 by 10 ft nylon nets either of 1/8 inch or 3/16 inch ace mesh. These were used in all types of habitats, usually with a high degree of success. They were used primarily as drag seines, but at times were used to block riffles and narrow runs while driving fish.

A longer nylon seine, 6 by 20 ft of 1/4 inch ace mesh, was used in shallow, snag-free areas in large streams and impoundments.

A large, flat, open area in Lake Springfield was sampled twice with a nylon bag seine 6 by 31 ft long and constructed of 3/8 inch ace mesh with a cubical bag of 1/4 inch ace mesh 6 ft to a side in the center.

Gill net sets were made in Lake Springfield, Lake Mexia, Lake

Normangee, in several potholes along the Navasota River and in the Navasota River floodplain during high water in June, 1968. Each gill net used was 6 ft long, with number 139 nylon webbing, and square mesh sizes of either 1, 1-1/2, 2 or 3 inches. Gill nets captured the only Ictiobus niger taken and were the only effective method for collecting larger I. bubalus and larger members of the genus Lepisosteus.

Hoop nets were used once in the Navasota River at locality 22. They proved effective in taking Cyprinus carpio, Pylodictis olivaris, Ictalurus punctatus, and Pomoxis annularis.

All specimens taken were fixed in 10% formalin, sorted, identified to species, and preserved in either 5% formalin or 40% isopropanol. Species were identified according to Eddy (1957), Hubbs (1964) and Moore (1968) and were deposited in the Texas Cooperative Wildlife Collection at Texas A&M University (TCWC).

The fish collections of the Texas Natural History Collection (TNHC) at the University of Texas at Austin and the Texas Cooperative Wildlife Collection were examined to gather information about fish ranges.

RESULTS

Collection Sites

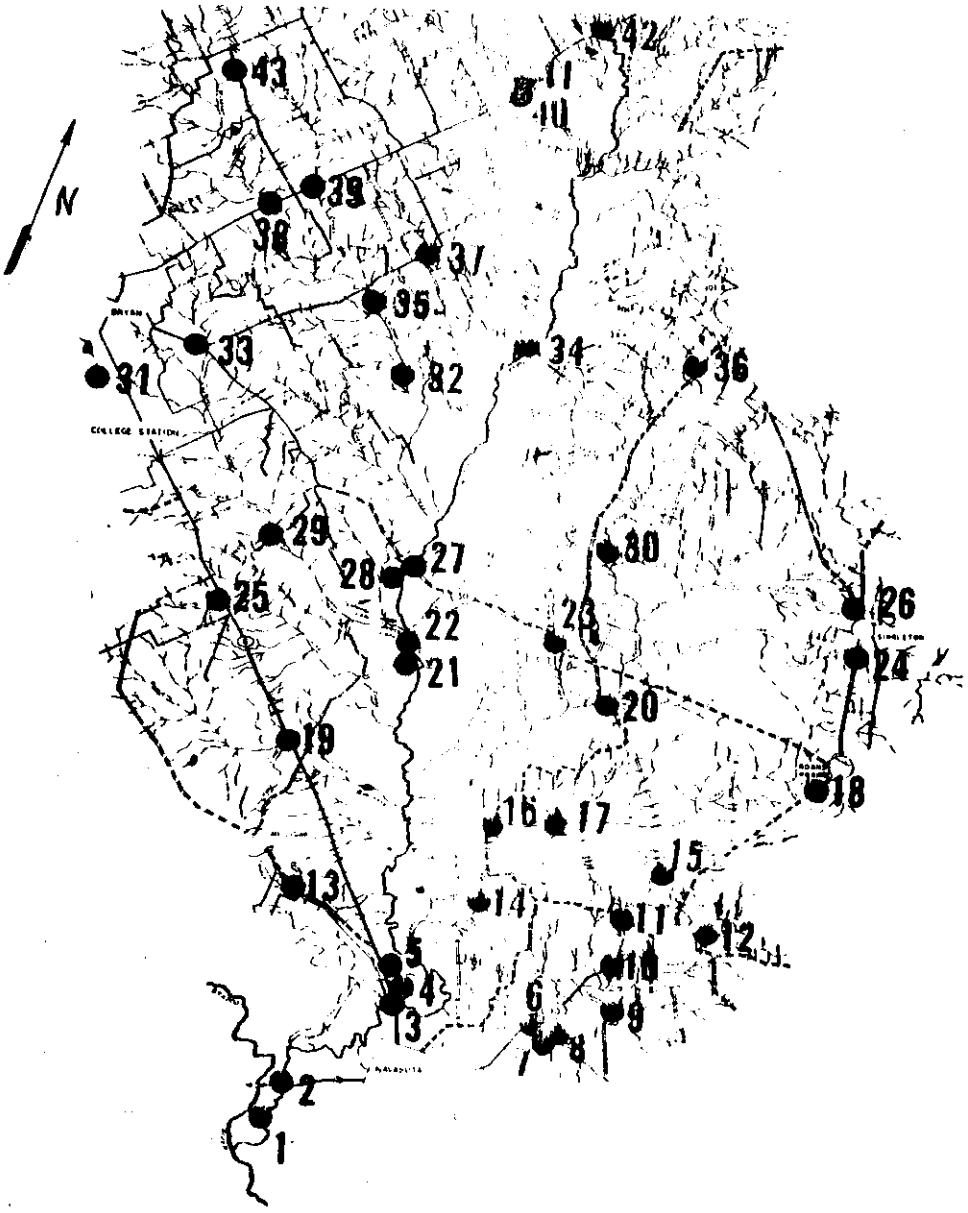
Between May 1967 and July 1968, 136 collections were made at 105 localities. These localities are shown in figures 3-5 and are described in Appendix A.

Habitat Variation

The habitats sampled varied from wide, sandy stretches of the river to narrow gravel-bottomed streams, and large mud-bottomed reservoirs on the upper reaches of the river (Table 1). Several gravel and sand riffles were present in the main river channel (station 22 at Sulphur Springs). There was little marginal aquatic vegetation in the river. However, pondweed, rushes and horsetails were present in some streams and lakes. In some parts of the river and tributaries, trash and large logs littered the streams bed so thickly that seining was impossible.

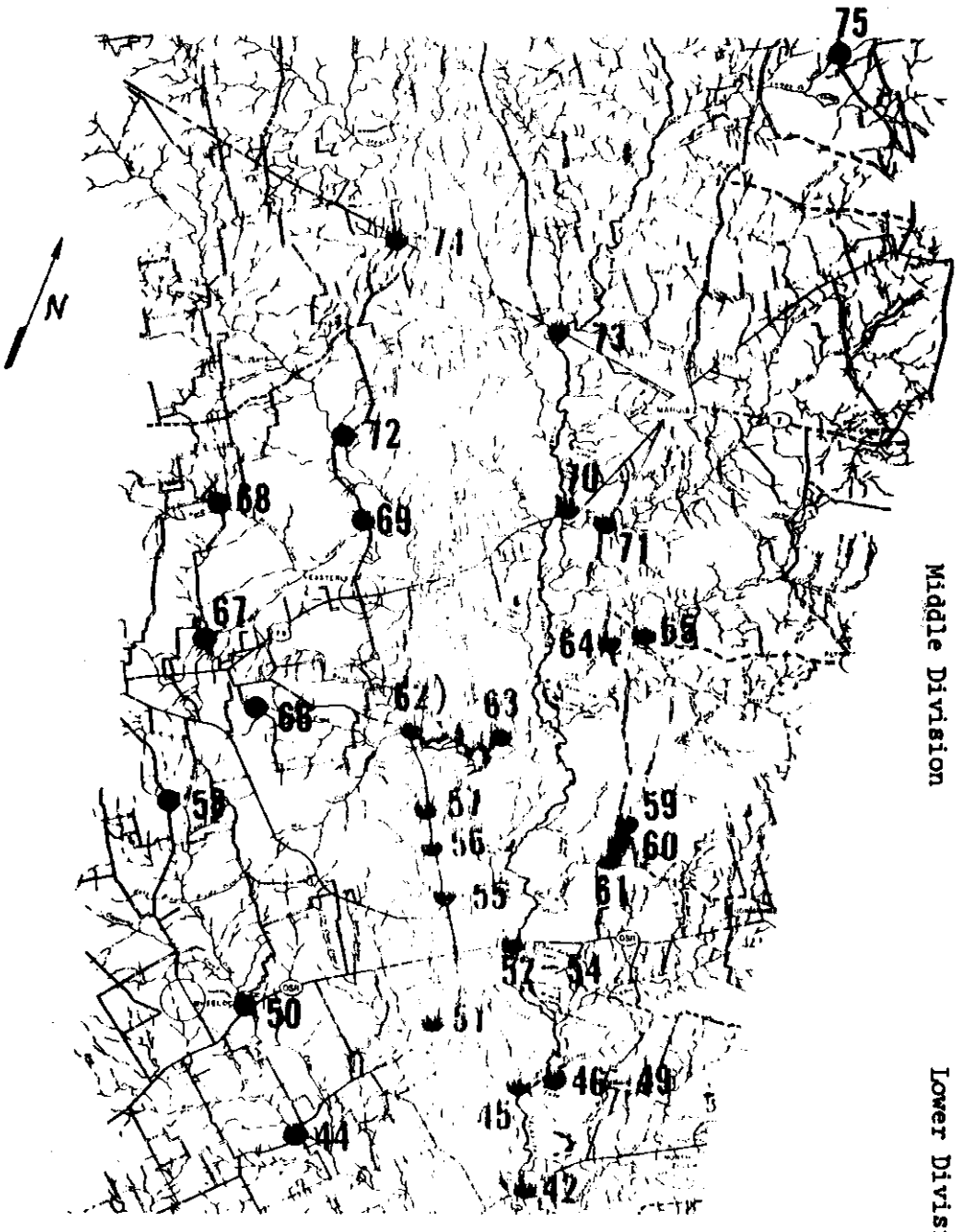
Numbers of Fish

A total of 21,000 fish specimens belonging to 56 species, 14 families and 9 orders were taken during this study. One species, an undescribed Percina, formerly considered to be P. caprodes, was found in the river channel and large reservoirs on the upper river. Several hybrids, presumed to be Notropis lutrensis X N. venustus, N. venustus X N. fumeus, Chaenobryttus gulosus X Lepomis spp., L. cyanellus X L. macrochirus, L. cyanellus X L. megalotis, L. megalotis X



NAVASOTA RIVER, TEXAS

SCALE



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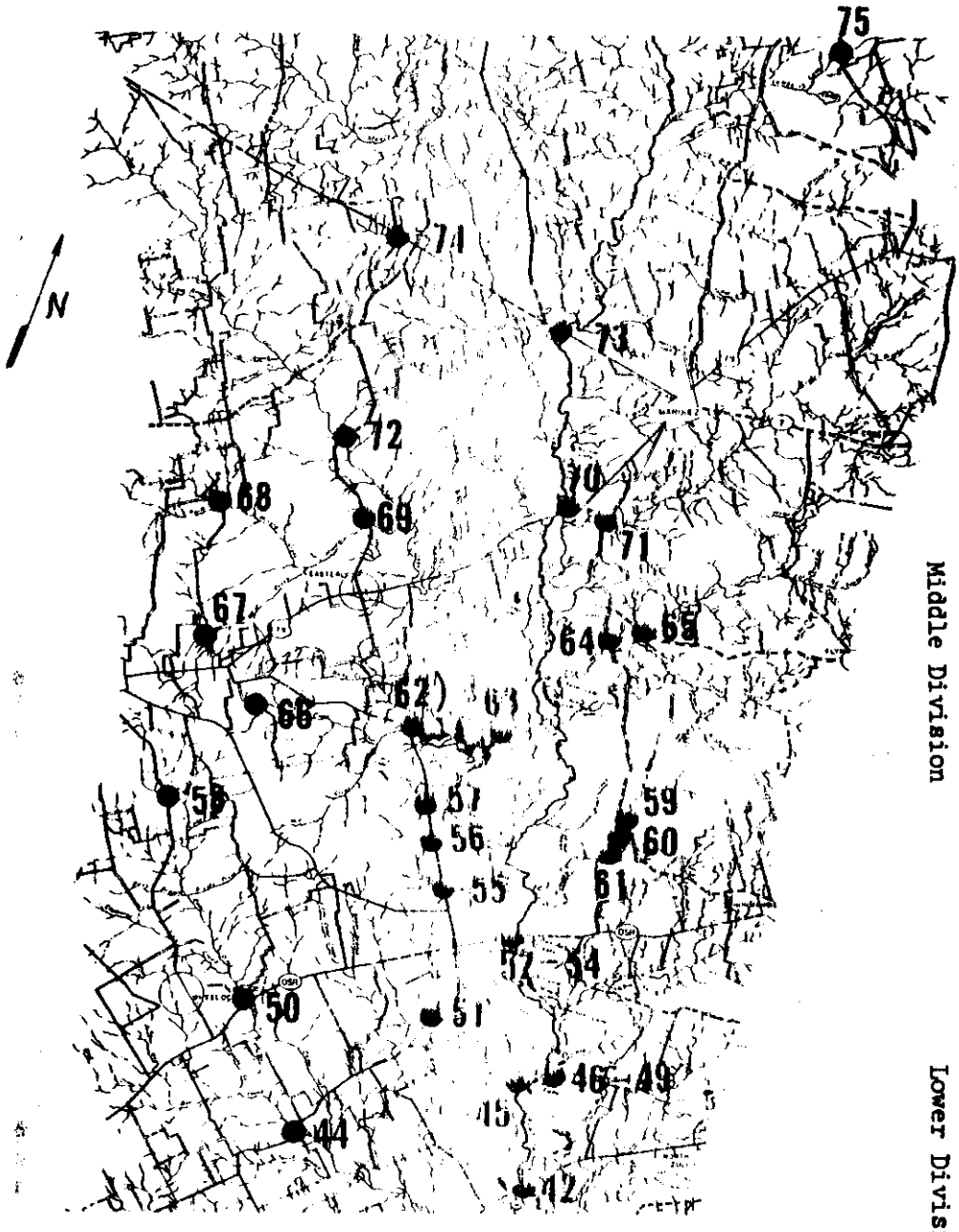

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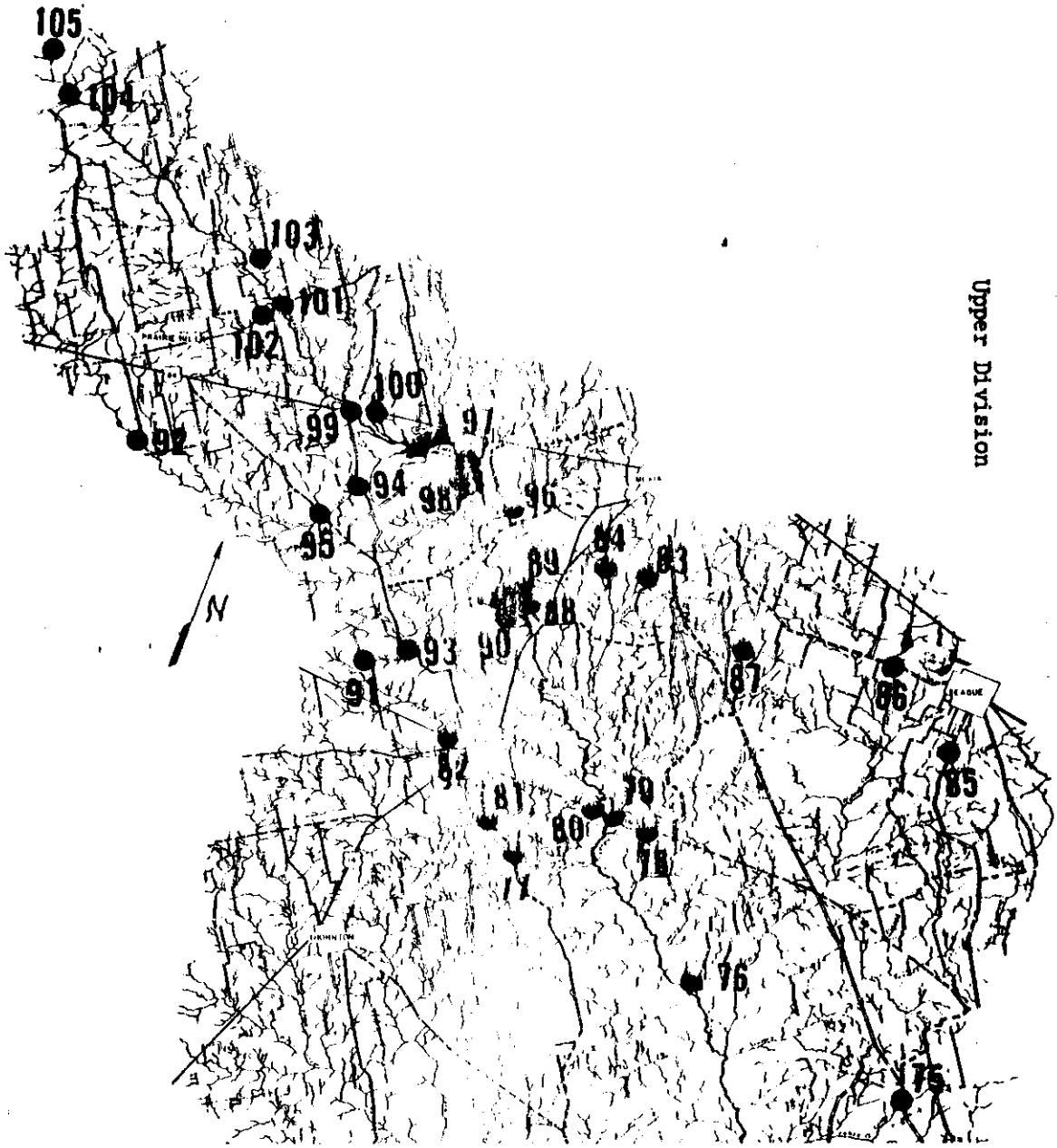

NAVASOTA RIVER, TEXAS

SCALE

Table 1.-Number of collections at each gradient and bottom type.

Gradient / Bottom	Channel	12 ft/mi	12 to 15 ft/mi	15 to 20 ft/mi	20+ ft/mi	Lentic	Total
Mud	10	1	1	10	0	26	50
Mud and sand	4	1	4	5	0	0	14
Sand	6	3	3	7	12	0	31
Sand and gravel	8	3	0	3	15	6	35
Rock	0	0	3	0	3	0	6
Total	28	8	11	27	30	32	136

L. humilis, were taken, most from the upper third of tributaries.

North to South Distribution of Fish Species

There was an increase in the number of species per locality from source to mouth of the Navasota River. Thirty-one localities in the upper division of the drainage averaged 7.45 species per locality. This section of the drainage passes through parts of the Blackland Prairie and Oak-Hickory Vegetation Regions and is similar in appearance to adjacent parts of the Brazos drainage. Twenty localities in the middle third of the drainage averaged 10.8 species per locality. Here the drainage passed through an area of hills and high-gradient in the Oak-Hickory Vegetation Region. Fifty-four localities in the lower division averaged 9.72 species per locality. This area covers parts of the Oak-Hickory, mixed Pine-Oak-Hickory and Fayette Prairie Regions (Kuchler, 1964).

Of 56 species taken in this survey, 24 were taken in all three divisions of the drainage (Table 2). These species were generally associated with a variety a habitats. Examples are Notropis fumeus, N. lutrensis, Pimephales vigilax, Fundulus olivaceous, Gambusia affinis, Lepomis megalotis, and L. macrochirus. Other species occurring in all three divisions were either characteristic of the main river channel, adjacent potholes, and oxbows (Lepisosteus oculatus, Ictiobus bubalus, Ictalurus punctatus) or were found mainly in low (12 ft/mi) gradient mud-bottom streams, the river channel and adjacent potholes (Opsopoeodus emiliae, Chaenobryttus gulosus, Pomoxis

Table 2

Species	Lower	Middle	Upper
Amia calva	3	-	-
Lepisosteus spatula	8	-	-
L. oculatus	33	1	2
L. osseus	5	-	-
Dorosoma cepedianum	153	14	386
D. petenense	74	-	-
Esox americanus	4	43	-
Cyprinus carpio	98	22	11
Notemigonus chrysoleucas	363	33	96
Opsopoeodus emiliae	450	26	22
Notropis fumeus	434	656	57
N. shumardi	56	-	20
N. lutrensis	3364	234	758
N. venustus	23	286	-
N. atrocaudalis	76	316	-
N. buchanani	106	-	-
Hybognathus nuchalis	132	12	-
Pimephales vigilax	470	111	112
P. promelas	1	-	-
Campostoma anomalum	41	14	-
Ictiobus niger	-	-	1
I. bubalus	16	-	12
Carpiodes carpio	17	1	1

Table 2

pecies	Lower	Middle	Upper
inytrema melanops	3	6	-
rimyzon oblongus	-	6	-
ctalurus punctatus	42	5	10
. furcatus	3	-	-
. melas	148	13	15
. natalis	82	-	34
ylodictis olivaris	41	-	-
oturus gyrinus	19	2	2
phredoderus sayanus	22	11	-
undulus notti	-	100	-
. notatus	15	5	1
. olivaceous	186	210	105
ambusia affinis	5150	512	1177
icropterus salmoides	72	40	93
. punctulatus	2	7	-
haenobryttus gulosus	150	37	59
epomis cyanellus	295	54	203
. symmetricus	1	14	-
. punctatus	-	12	-
. microlophus	1	43	-
. marginatus	2	-	-
. megalotis	438	103	152
. humilis	122	18	102

Table 2

Species	Lower	Middle	Upper
L. macrochirus	716	178	334
Pomoxis nigromaculatus	5	-	-
P. annularis	236	60	124
Elassoma zonatum	10	5	-
Percina sciera	14	46	-
P. sp.	9	-	11
Etheostoma chlorosomum	98	26	8
E. parvipinne	-	17	-
E. gracile	105	73	27
Aplodinotus grunniens	4	-	4

annularis).

Nine species were taken only in the lower two divisions of the drainage. These were generally fish inhabiting riffles or relatively high gradients (over 15 ft/ mi) with sand and gravel-bottoms.

A single species, Lepomis microlophus, was taken only from the upper two divisions of the drainage, usually from sand-bottomed streams and impoundments.

The six species taken only from the upper and lower divisions of the drainage were generally associated with river channels. Their absence from the middle third of the drainage probably reflects the low number of collections made in the river channel in this division of the study area.

Twelve species were collected only in the lower division of the drainage. Many of these species, such as Amia calva, Lepisosteus spatula, L. osseus, Dorosoma petenense, Lepomis marginatus, and Pomoxis nigromaculatus were associated with slow-flowing streams or standing water. Others, including Ictalurus furcatus and Pylodictis olivaris, occurred over sand or gravel bottoms in the river channel.

Of the four species found only in the middle division of the drainage, three, Fundulus notti, Erimyzon oblongus and Lepomis punctatus, were found in marshy backwater or impounded areas or in streams of low to medium gradient. The other species found only in this area was Etheostoma parvipinne, a riffle-frequenting fish of high gradient streams.

East-West Distribution of Fish Species

Twenty-two species were taken from both the east and west tributaries, channel, and floodplain (Table 3). With seven exceptions, these were the same species taken in all north to south divisions of the drainage. Of these 22 species, three, (Hybognathus nuchalis, Lepomis microlophus, Etheostoma chlorosomum) were not taken in all north-south divisions. Four species (Lepisosteus oculatus, Notropis venustus, Ictalurus punctatus, and Fundulus notatus) found in all three divisions from north to south were not found in all divisions from east to west.

Five species were not taken from eastern tributaries. These were Lepisosteus spatula, Opsopoeodus emiliae, Ictiobus bubalus, Ictalurus natalis, and Pomoxis nigromaculatus. All were found in mud-bottomed streams, potholes, and impoundments.

Lepisosteus oculatus and Ictalurus punctatus were found only in the floodplain and channel. L. oculatus was found in the river channel, potholes in the floodplain and in oxbows and impoundments. I. punctatus generally was found in the river channel, associated potholes and impoundments.

Species caught in the channel and tributaries but not in the floodplain were: Notropis fumeus, taken in the channel and tributaries over sand bottoms; Micropterus punctulatus, taken in the channel and tributaries over sand and gravel bottom, and Percina sciera caught in larger streams over sand and gravel bottoms in riffle areas.

Three species were not caught in the tributaries. Dorosoma

Table 3

Species	East	Floodplain	Channel	West
Amia calva	-	3	-	-
Lepisosteus spatula	-	3	3	2
L. oculatus	1	16	19	-
L. osseus	-	5	-	-
Dorosoma cepedianum	3	90	431	29
D. petenense	-	50	24	-
Esox americanus	34	1	-	12
Cyprinus carpio	21	40	22	28
Notemigonus chrysoleucas	165	62	65	200
Opsopoeodus emiliae	1	47	405	45
Notropis fumeus	214	-	259	674
N. shumardi	-	-	76	-
N. lutrensis	1179	33	2734	410
N. venustus	88	-	-	221
N. atrocaudalis	41	-	-	321
N. buchanani	-	-	101	5
Hybognathus nuchalis	12	18	59	55
Pimephales vigilax	174	5	412	48
P. promelas	-	-	-	1
Campostoma anomalum	41	-	-	15
Ictiobus niger	-	-	1	-
I. bubalus	-	14	13	1
Carpiodes carpio	3	-	7	9

Table 3

Species	East	Floodplain	Channel	West
Minytrema melanops	1	–	1	8
Erimyzon oblongus	4	–	–	3
Ictalurus punctatus	2	7	49	–
I. furcatus	–	–	3	–
I. melas	28	60	30	58
I. natalis	–	45	56	15
Pylodictis olivaris	–	32	8	–
Noturus gyrinus	7	8	6	3
Aphredoderus sayanus	8	17	–	8
Fundulus notti	100	–	–	–
F. notatus	12	2	2	4
F. olivaceous	213	43	3	242
Gambusia affinis	2070	1155	2460	935
Micropterus salmoides	82	16	82	25
M. punctulatus	3	–	6	1
Chaenobryttus gulosus	66	86	61	47
Lepomis cyanellus	226	41	94	191
L. symmetricus	14	–	–	1
L. punctuatus	12	–	–	–
L. microlophus	44	1	1	9
L. marginatus	–	–	–	2
L. megalotis	197	12	250	134
L. humilis	11	51	149	31

Table 3

Species	East	Floodplain	Channel	West
L. macrochirus	277	458	127	316
Pomoxis nigromaculatus	-	4	-	1
P. annularis	75	199	82	64
Elassoma zonatum	14	1	-	-
Percina sciera	23	-	7	23
P. sp.	-	-	6	14
Etheostoma chlorosomum	36	12	63	21
E. parvipinne	3	-	-	14
E. gracile	74	16	26	89
Aplodinotus grunniens	-	1	7	-

petenense was found over sand bottoms in the channel and in potholes. Pylodictis olivaris was found over sand and gravel in the lower river channel and in potholes. Aplodinotus grunniens was found in the river channel, an oxbow, and a reservoir.

N. buchanani and Percina sp. were both found only in the channel and one creek in the western drainage. Both were found over sand and mud bottoms. Percina sp. was also caught in Lakes Springfield and Mexia on the upper river.

Elassoma zonatum, taken only in the floodplain and eastern drainage, was collected in several low-gradient localities and one pothole. All localities had some form of emergent vegetation.

Five species were never collected from the channel or floodplain. Four of these (Notropis atrocaudalis, N. venustus, Campostoma anomalum, and Etheostoma parvipinne) were limited to high gradient sand and/or gravel bottom streams. The other species (Lepomis symmetricus) was taken from Lake Normangee and Running Creek and two sand and mud-bottom creeks.

Two species were collected only from the river channel. These were Notropis shumardi and Ictalurus furcatus, found over sand and gravel bottoms. Ictiobus niger (one specimen) was found only in Lake Springfield over a mud bottom.

Amia calva and Lepisosteus osseus were taken only from borrow pits, oxbows, and potholes in the floodplain.

Pimephales promelas and Lepomis marginatus were taken only from the western drainage. P. promelas was taken from Country Club Lake.

in Bryan; L. marginatus from a sand and mud bottom creek east of Bryan.

Fundulus notti and Lepomis punctatus were both taken only from Running Creek and Normangee Lake in the eastern drainage.

Habitat of the Fish Species in the Navasota River System

Thirty-one of the 56 species taken were present in sufficient numbers and from enough collecting localities to allow statements to be made about their habitats (Tables 4-6).

Twenty-four of these were widespread throughout the drainage in a variety of gradients and bottom types (Tables 4 and 5): Dorosoma cepedianum, Esox americanus, Cyprinus carpio, Notemigonus chrysoleucas, Opsopoeodus emiliae, Notropis fumeus, N. lutrensis, Hybognathus nuchalis, Pimephales vigilax, Capriodes carpio, Ictalurus melas, Noturus gyrinus, Fundulus olivaceous, Gambusia affinis, Micropterus salmoides, Chaenobryttus gulosus, Lepomis cyanellus, L. megalotis, L. macrochirus, Pomoxis annularis, Percina sciera, Etheostoma chlorosomum, and E. gracile. Most of these species were found over all the drainage. Some such as D. cepedianum, O. emiliae, C. gulosus, I. melas, and Pomoxis annularis showed a preference for slower waters and muddy bottoms. Some such as E. americanus, Notemigonus chrysoleucas, Notropis fumeus, F. olivaceous, L. megalotis, P. sciera, and E. chlorosomum preferred higher (15 + ft/mi) gradients and sandy or gravel bottoms in streams of less than 10 ft in width. The others showed no obvious preferences, usually being found in

relatively equal numbers in all types of habitats.

The rest of the species were more restricted in habitat type. Lepisosteus oculatus, Ictiobus bubalus, and Ictalurus punctatus were almost exclusively associated with the river channel, especially in the large impoundments on the northern river, and potholes in the floodplain. Aphredoderus sayanus was found in low-gradient streams, potholes in the floodplain, and deep pools in high-gradient streams, but never in the main river channel.

Notropis venustus, Notropis atrocaudalis, and Campostoma anomalum were confined to high-gradient, sandy or gravel-bottom streams usually in the east and west-central and southeast sections of the drainage. These streams always had deep-cut banks, were well shaded and generally were under 10 ft in width.

Among the remaining 25 species, a few were taken in sufficient numbers to suggest vague patterns of habitat preference. The undescribed Percina, Notropis shumardi, N. buchanani, Ictalurus furcatus, and Pylodictis olivaris were taken from the Navasota River channel, usually over sand bottoms. Many juvenile P. olivaris were taken from one pothole (locality 21) near Sulphur Springs.

Lepisosteus oculatus, Dorosoma petenense, and Aplodinotus grunniens were taken from the channel over sand and mud bottoms and associated potholes. A. grunniens was also found in Springfield Lake on the upper river.

Erimyzon oblongus, Fundulus notti, Lepomis symmetricus, L. punctatus, and Elassoma zonatum were all found in Normangee Lake,

which was formed by damming a marshy area on Running Creek in Leon County. This lake was choked with Elodea and the bottom was covered with a thick layer of decaying plant matter. E. oblongus was also taken from Camp Creek Lake, a similar lake in Robertson County. The water in both places was very clear and Esox americanus was very numerous in both lakes. F. notti was taken only in Lake Normangee and Running Creek above and below the impoundment. L. symmetricus was also taken in Running Creek and rain-swollen Wickson Creek east of Bryan. Both of these creeks were sandy-bottomed with gradient between 13 and 17 ft/mi. E. zonatum was taken in several other localities which had little or no current, mud bottom and emergent vegetation.

Minytrema melanops and Fundulus notatus were taken from tributaries with sandy bottoms and a gradient generally greater than 15 ft/mi. Both were taken from potholes in the floodplain on one occasion. F. notatus was taken from the river twice, both times over sand bottoms.

Ictalurus natalis was found in potholes, in the channel over sandy bottoms and in streams of less than 12 ft/mi gradient with various bottom types.

Micropterus punctulatus was found twice in the Navasota River (once over sand, once over mud), both times in very fast currents after heavy rains. The spotted bass was also taken from two streams which had sand and gravel bottoms and gradients less than 15 ft/mi.

Lepomis microlophus was generally found in impoundments and

Table 4

Species	Mud	Mud & sand	Sand	Sand & gravel	Bedrock
Amia calva	(5)3	-	-	-	-
Lepisosteus spatula	(5)3	-	(1)2	(8)3	-
L. oculatus	(12)19	-	(2)1	(8)16	(2)21
L. osseus	(6)5	-	-	-	-
Dorosoma cepedianum	(12)199	(3)13	(5)30	(12)290	(2)21
D. petenense	(2)50	-	(2)22	(8)2	-
Esox americanus	(5)10	(1)1	(7)28	(5)8	-
Cyprinus carpio	(13)76	(3)3	(5)19	(9)33	-
Notemigonus chrysoleucas	(18)224	(9)55	(13)89	(18)79	(5)45
Opsopoeodus emiliae	(17)246	(3)30	(5)38	(13)184	-
Notropis fumeus	(2)20	(2)45	(12)635	(20)452	(2)4
N. shumardi	(1)16	(6)60	-	-	-
N. lutrensis	(18)843	(6)1306	(16)491	(26)1495	(5)221
N. venustus	-	-	(6)226	(5)83	-
N. atrocaudalis	(1)1	(1)5	(5)145	(14)201	(2)10
N. buchanani	(4)28	-	(2)66	(9)12	-
Hybognathus nuchalis	(6)54	(3)8	(6)43	(13)39	-
Pimephales vigilax	(8)39	(5)165	(10)110	(22)281	(5)42
P. promelas	(1)1	-	-	-	-
Campostoma anomalum	-	-	(4)28	(5)15	(2)12
Ictiobus niger	(1)1	-	-	-	-

Table 4

Species	Mud	Mud & sand	Sand	Sand & gravel	Bedrock
Ictiobus bubalus	(10)22	-	(1)1	(8)5	-
Carpiodes carpio	(2)8	(4)2	-	(13)8	(1)1
Minytrema melanops	(1)1	(1)1	(2)1	(5)6	-
Erimyzon sucetta	(3)7	-	-	-	-
Ictalurus punctatus	(9)22	(4)6	(5)14	(12)16	-
I. furcatus	(2)1	-	(2)1	(8)1	-
I. melas	(12)109	(4)11	(7)28	(12)27	(1)1
I. natalis	(5)56	-	-	(9)60	-
Pylodictis olivaris	(5)32	-	(2)1	(8)8	-
Noturus gyrinus	(7)10	(4)2	(2)1	(14)10	-
Aphredoderus sayanus	(2)17	(2)1	(6)8	(6)7	-
Fundulus notti	(2)14	-	(3)86	-	-
F. notatus	(3)3	-	(1)1	(6)17	-
F. olivaceous	(9)53	(7)41	(14)178	(22)229	-
Gambusia affinis	(39)2794	(14)1098	(26)926	(43)1680	(3)122
Micropterus salmoides	(24)78	(4)16	(12)47	(19)33	(3)4
M. punctulatus	(1)1	-	(3)5	(4)3	-
Chaenobryttus gulosus	(26)176	(10)28	(10)22	(19)32	-
Lepomis cyanellus	(25)216	(13)42	(24)147	(32)132	(4)15
L. symmetricus	(2)6	(2)1	(2)8	-	-
L. punctatus	(2)10	-	(2)2	-	-

Table 4

Species	Mud	Mud & sand	Sand	Sand & gravel	Bedrock
L. microlophus	(6)33	-	(3)13	(7)9	-
L. marginatus	-	(2)2	-	-	-
L. humilis	(17)94	(6)36	(11)51	(12)59	(1)2
L. macrochirus	(38)596	(11)221	(21)118	(16)238	(4)5
Pomoxis nigromaculatus	(4)4	(2)1	-	-	-
P. annularis	(33)235	(8)36	(8)62	(12)84	(2)3
Elassoma zonatum	(3)3	(1)9	(2)3	-	-
Percina sciera	-	(1)5	(6)25	(15)30	-
P. sp.	(2)3	-	-	(13)17	-
Etheostoma chlorosomum	(11)40	(2)2	(7)34	(16)56	-
E. parvipinne	-	-	-	(7)17	-
E. gracile	(14)47	(5)13	(12)65	(20)80	-
Aplodinotus grunniens	(3)7	-	-	(4)1	-

Table 5

Species	Lentic	12 ft/mi or less	12 to 15 ft/mi	15 to 20 ft/mi	20 ft/mi or more
Amia calva	(5)3	-	-	-	-
Lepisosteus spatula	(5)3	(8)3	-	-	(1)2
L. oculatus	(9)19	(10)17	-	-	-
L. osseus	(6)5	-	-	-	-
Dorosoma cepedianum	(17)454	(16)72	(4)25	(1)2	-
D. petenense	(2)50	(10)26	-	-	-
Esox americanus	(6)12	(1)1	(1)1	(7)26	(3)6
Cyprinus carpio	(11)35	(12)45	(3)9	(2)26	(2)16
Notemigonus chrysoleucas	(12)83	(13)72	(8)59	(17)173	(12)105
Opsopoeodus emiliae	(9)66	(19)402	(1)2	(5)27	(4)2
Notropis fumeus	-	(14)254	(2)33	(7)114	(18)746
N. shumardi	-	(7)76	-	-	-
N. lutrensis	(10)324	(25)2760	(4)198	(12)386	(18)773
N. venustus	-	(1)14	(2)9	(5)89	(6)197
N. atrocaudalis	-	-	(2)15	(4)11	(17)336
N. buchanani	-	(15)106	-	-	-
Hybognathus nuchalis	(4)18	(12)59	(1)1	(3)38	(7)28
Pimephales vigilax	(3)87	(22)362	(8)5	(5)79	(7)106
P. promelas	(1)1	-	-	-	-
Campostoma anomalum	-	-	-	-	(11)55
Ictiobus niger	(1)1	-	-	-	-

Table 5

Species	Lentic	12 ft/mi or less	12 to 15 ft/mi	15 to 20 ft/mi	20 ft/mi or more
I. bubalus	(10)21	(9)6	-	-	(1)1
Carpiodes carpio	(1)7	(8)8	(2)1	-	(7)3
Minytrema melanops	(1)1	(2)4	(1)1	(3)1	(2)2
Erimyzon oblongus	(3)7	-	-	-	-
Ictalurus punctatus	(11)15	(16)40	-	-	(1)2
I. furcatus	-	(12)3	-	-	-
I. melas	(9)65	(12)27	(3)6	(9)47	(6)31
I. natalis	(4)37	(11)79	-	-	-
Pylodictis olivaris	(11)32	(4)9	-	-	-
Noturus gyrinus	(6)8	(12)9	(4)2	-	(5)4
Aphredoderus sayanus	(3)18	(1)5	(4)4	(2)3	(7)3
Fundulus notti	(2)14	-	-	(3)86	-
F. notatus	(3)3	(2)2	-	-	(5)16
F. olivaceous	(7)49	(14)10	(6)42	(13)122	(12)278
Gambusia affinis	(24)1573	(33)3270	(12)254	(23)589	(21)924
Micropterus salmoides	(17)70	(16)50	(5)8	(13)22	(12)55
M. punctulatus	-	(4)6	-	(3)3	-
Chaenobryttus gulosus	(20)107	(29)67	(3)11	(10)55	(7)20
Lepomis cyanellus	(14)50	(28)185	(10)19	(20)157	(20)141
L. symmetricus	(2)6	-	(2)1	(2)8	-

Table 5

Species	Lentic	12 ft/mi or less	12 to 15 ft/mi	15 to 20 ft/mi	20 ft/mi or more
L. punctatus	(2)10	-	-	(2)2	-
L. microlophus	(14)31	-	-	(4)18	(2)6
L. marginatus	-	-	(2)2	-	
L. megalotis	(18)141	(29)224	(1)6	(10)58	(14)164
L. humilis	(13)113	(25)112	(4)6	(2)10	(1)1
L. macrochirus	(21)513	(32)416	(9)30	(18)141	(18)78
Pomoxis annularis	(24)201	(14)197	(9)12	(6)8	(1)2
P. nigromaculatus	(3)3	(1)1	(2)1	-	-
Elassoma zonatum	(3)3	(1)9	-	(2)3	-
Percina sciera	-	(12)28	(2)7	(4)8	(6)17
P. sp.	(6)11	(10)9	-	-	-
Etheostoma chlorosomum	(7)13	(9)86	(1)2	(7)10	(12)21
E. parvipinne	-	(2)13	-	(3)1	(2)3
E. gracile	(6)19	(9)39	(4)10	(13)47	(19)90
Aplodinotus grunniens	(6)5	(1)3	-	-	-

sand bottom streams with gradients of 15 ft/mi or more.

Amia calva, Lepisosteus osseus and Pomoxis nigromaculatus were found in potholes in the lower river floodplain.

Etheostoma parvipinne was always found in fast currents over pebble, gravel and/or sand bottoms in well-shaded streams which usually had deep-cut banks.

Pimephales promelas, Ictiobus niger, and Lepomis marginatus were all taken once each. P. promelas was taken in Country Club Lake in Bryan; it probably was a bait release. I. niger was caught in Lake Springfield, a large impoundment of 4004 acres on the upper Navasota River. Lepomis marginatus was taken in Wickson Creek, a sand bottom creek of 13 ft/mi gradient east of Bryan.

Table 6

Species	10 ft or less	More than 10 ft
Lepisosteus spatula	–	(1) 2.0
Dorosoma cepedianum	(4) 1.0	(6) 12.83
Esox americanus	(7) 4.42	(4) 0.5
Cyprinus carpio	(7) 6.57	(2) 2.0
Notemigonus chrysoleucas	(23) 6.82	(10) 12.9
Opsopoeodus emiliae	(2) 2.5	(4) 2.5
Notropis fumeus	(12) 59.99	(11) 16.6
N. lutrensis	(16) 38.0	(16) 26.8
N. venustus	(5) 45.0	(3) 27.3
N. atrocaudalis	(13) 26.61	(8) 2.5
N. buchanani	–	(1) 5.0
Hybognathus nuchalis	(4) 11.5	(5) 4.0
Pimephales vigilax	(9) 10.0	(15) 5.26
Campostoma anomalum	(5) 7.2	(6) 2.83
Ictiobus bubalus	–	(1) 1.0
Carpiodes carpio	(3) 0.67	(6) 0.5
Minytrema melanops	(4) 0.75	(5) 0.'
Ictalurus punctatus	(1) 2.0	
I. melas	(8) 1.0	
I. natalis	(1) 15.0	
Noturus gyrinus	(5) 0.6	
Aphredoderus sayanus	(8) 1.5	
Fundulus notti	(3) 28.67	

Table 6

Species	10 ft or less	More than 10 ft
F. notatus	-	(5) 3.2
F. olivaceous	(23) 14.56	(13) 8.46
Gambusia affinis	(35) 38.43	(25) 43.84
Micropterus salmoides	(19) 2.68	(13) 3.0
M. punctulatus	-	(4) 1.0
Chaenobryttus gulosos	(12) 3.16	(10) 5.0
Lepomis cyanellus	(39) 6.94	(22) 6.0
L. symmetricus	(4) 2.25	-
L. punctatus	(2) 1.0	-
L. microlophus	(4) 4.8	-
L. marginatus	(2) 1.0	-
L. megalotis	(14) 8.78	(16) 11.31
L. humilis	(8) 4.0	(6) 1.67
L. macrochirus	(23) 6.3	(22) 6.0
Pomoxis nigromaculatus	(1) 1.0	-
P. annularis	(8) 1.0	(6) 1.83
Elassoma zonatum	(3) 1.3	(1) 9.0
Percina sciera	(7) 6.58	(7) 1.14
P. sp.	-	(1) 3.0
Etheostoma chlorosomum	(11) 4.27	(8) 4.0
E. parvipinne	(4) 4.0	(3) 0.3
E. gracile	(22) 5.54	(4) 1.4

Species Absent From the Navasota River Drainage but Found in Texas East and West of the Navasota River Drainage

Some species are found in more western drainages but were not collected in the Navasota River drainage, these include: Notropis amablis, Hybognathus placitus, Dionda episcopa, Pimephales promelas, Campostoma anomalum, Ictalurus lupus, Etheostoma lepidum, Ambloplites rupestris, Micropterus treculi, and Cichlasoma cyanoguttatum (Jurgens, 1951; Trevino, 1955; Brown, 1953, Tilton, 1961; and based on specimens in TMMC and TCWC).

Two Notropis amablis in the Texas Cooperative Wildlife Collection (No 2593) are labeled as being from the Navasota River. This record and one from Henderson County (No 1705) are believed to be erroneous because all other data indicate N. amablis is limited to limestone streams of the Balconian Region in Texas (Hubbs, 1957).

Hybognathus placitus is found from the Brazos River south and west to the Rio Grande and into Mexico (Hubbs, 1954).

Dionda episcopa is found in the Balconian and Chihuahuan of Texas (Hubbs, 1957).

Etheostoma lepidum is limited to the limestone streams of the Balconian Province of Texas (Hubbs, 1957).

Ambloplites rupestris has been introduced into the Comal and San Marcos Rivers of the Guadalupe River System (Brown, 1953).

Micropterus treculi is native to the streams in the northern Balconian of Texas (Hubbs, 1957).

Cichlasoma cyanoguttatum is mostly limited to the Tamaulipan province of Texas (Hubbs, 1957), but is known from the San Marcos (Jurgens, 1951) the Colorado (Tilton, 1961) and the Guadalupe (Hubbs, Kuenhe and Ball, 1953) drainages, probably as introductions.

Other species are found to the east of the Navasota River but are absent from the Navasota drainage and farther west. These include Moxostoma poecilurum, Notropis umbratilis, N. sabinae, Ammocrypta vivax, A. clara, Noturus nocturnus, and Centrarchus macropterus (Hubbs, 1957).

According to Hubbs (1957) and my examination of the fish collections at the University of Texas, and Texas A&M University, M. poecilurum ranges through the Austroriparian, probably reaching a western limit in the San Jacinto drainage near Conroe, Texas (Laswell, 1968).

Hubbs (1957) gives the range of N. umbratilis as north and east of a line from Fort Worth to Houston. Laswell (1968) reported it from the west fork of the San Jacinto River.

According to Hubbs (1957) the range in Texas of Noturus nocturnus closely approximates that of Notropis umbratilis.

Notropis sabinae is limited to the Austroriparian of Texas reaching its western limits in the west fork of the San Jacinto River (Laswell, 1968).

The ranges of Ammocrypta vivax and A. clara correspond to the boundary of the Oak-Hickory and Pine-Oak-Hickory regions (Hubbs, 1957). A. vivax was expected in this survey but was not found, although there was extensive collecting where the two regions

theoretically meet in Leon County. Laswell (1968) collected it from the San Jacinto River.

The western limits of the range of Centrarchus macropterus correspond with the western limit of the Austroriparian (Hubbs, 1957).

Some species have been taken in drainages both to the east and to the west of the Navasota drainage, but were not reported or verified from the Navasota River or taken in my study. These include Moxostoma congestum, Notropis deliciosus, N. amnis, N. stramineus, N. volucellus, N. texanus, Phenacobius mirabilis, Fundulus chrysotus, Etheostoma spectabile, and Percina shumardi.

"Moxostoma congestum in Texas is chiefly limited to the Balconian... into the Chihuahuan and Texan... to the coastal prairie and Brazos-Trinity divide", according to Hubbs (1957). However, Laswell (1968) took it from the west fork of the San Jacinto River, well within the Austroriparian.

Notropis deliciosus is limited in Texas to the Balconian province and the Red River drainage (Hubbs, 1957; TNHC, TCWC).

Notropis amnis is found in the Austroriparian and in the Texan south of the Tamaulipan (Hubbs, 1957). This species is recorded from the Navasota drainage but specimens are not in the Texas Cooperative Wildlife Collection (M-3-d-46).

Notropis stramineus is found in Texas in the Balconian and Chihuahuan. There is one collection from Denton County, Trinity River drainage, in the Texas Cooperative Wildlife Collection. Laswell (1968) reported it from the San Jacinto River.

Notropis volucellus occupies the Texas, Austroriparian, and Balconian provinces in Texas except for the Nueces River (Hubbs, 1957). Specimens in The Texas Cooperative Wildlife Collection were found to be Notropis buchanani which was formerly considered to be a subspecies of N. volucellus (Trautman, 1957).

Notropis texanus and Percina shumardi occur east of the Trinity-Neches divide. N. texanus is common in the lower Colorado, Guadalupe, and Nueces drainages. P. shumardi is common in the lower Guadalupe River (Hubbs, 1957).

Phenacobius mirabilis is found in northeast Texas and the Colorado drainage east of the Balcones Escarpment (Hubbs, 1957).

Fundulus chrysotus ranges within the Austroriparian of Texas except on the coast where it reaches Matagorda County in the Colorado drainage (Hubbs, 1957).

Etheostoma spectabile has been reported from the Red River and Upper Trinity River systems of Texas and the Brazos River above and below the mouth of the Navasota River. It is found in the Texas and Balconian provinces, but does not extend south of the Guadalupe-Nueces divide (Hubbs, 1957).

Cichlasoma cyanoguttatum is mostly limited to the Tamaulipan province of Texas (Hubbs, 1957), but is known from the San Marcos (Jurgens, 1951) the Colorado (Tilton, 1961) and the Guadalupe (Hubbs, Kuenhe and Ball, 1953) drainages, probably as introductions.

Other species are found to the east of the Navasota River but are absent from the Navasota drainage and farther west. These include Moxostoma poecilurum, Notropis umbratilis, N. sabinae, Ammocrypta vivax, A. clara, Noturus nocturnus, and Centrarchus macropterus (Hubbs, 1957).

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theoretically meet in Leon County. Laswell (1968) collected it from the San Jacinto River.

The western limits of the range of Centrarchus macropterus correspond with the western limit of the Austroriparian (Hubbs, 1957).

Some species have been taken in drainages both to the east and to the west of the Navasota drainage, but were not reported or verified from the Navasota River or taken in my study. These include Moxostoma congestum, Notropis deliciosus, N. amnis, N. stramineus, N. volucellus, N. texanus, Phenacobius mirabilis, Fundulus chrysotus, Etheostoma spectabile, and Percina shumardi.

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Notropis stramineus is found in Texas in the Balconian and Chihuahuan. There is one collection from Denton County, Trinity River drainage, in the Texas Cooperative Wildlife Collection. Laswell (1968) reported it from the San Jacinto River.

Statewide Ranges of Fish Species Found in the Navasota Drainage.

Some species of the Navasota fauna range over most or all of the state. These include Lepisosteus osseus, Dorosoma cepedianum, Cyprinus carpio, Notropis lutrensis, Pimephales vigilax, Ictiobus bubalus, Carpiodes carpio, Gambusia affinis, Chaenobryttus gulosus, and Aplodinotus grunniens.

Others have had their ranges so altered by introductions as food, bait or sport fishes that their native range limits are uncertain. These include Astyanax fasciatus, Notemigonus chrysoleucas, Ictalurus furcatus, I. punctatus, I. melas, Micropterus salmoides, Lepomis microlophus, L. megalotis, L. cyanellus, L. auritus, L. macrochirus, Pomoxis annularis, and P. nigromaculatus.

Astyanax fasciatus in Texas is limited to the Tamaulipan and Chihuahuan biotic provinces except where introduced (Hubbs, 1957). It has been found in the Colorado River (Tilton, 1961), Guadalupe (Hubbs, Kuenhe and Ball, 1952), San Marcos (Jurgens, 1951), and Rio Grande (Trevino, 1955). The records taken from the Navasota (TCWC 1183) probably represent a bait release.

Other species reach their eastern limits at or near the Navasota drainage. Campostoma anomalum apparently reaches its southeastern limits in the southeastern Navasota drainage. It has been reported from the Red River and Trinity River systems of northeast Texas and in the Brazos River above and below the mouth of the Navasota River. One specimen is labeled from the San Jacinto drainage (TCWC M-3-e-7) but data for collector and exact locality were lacking.

Notropis volucellus occupies the Texas, Austroriparian, and Balconian provinces in Texas except for the Nueces River (Hubbs, 1957). Specimens in The Texas Cooperative Wildlife Collection were found to be Notropis buchanani which was formerly considered to be a subspecies of N. volucellus (Trautman, 1957).

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Fundulus chrysotus ranges within the Austroriparian of Texas except on the coast where it reaches Matagorda County in the Colorado drainage (Hubbs, 1957).

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Some species of the Navasota fauna range over most or all of the state. These include Lepisosteus osseus, Dorosoma cepedianum, Cyprinus carpio, Notropis lutrensis, Pimephales vigilax, Ictiobus bubalus, Carpiodes carpio, Gambusia affinis, Chaenobryttus gulosus, and Aplodinotus grunniens.

Others have had their ranges so altered by introductions as food, bait or sport fishes that their native range limits are uncertain. These include Astyanax fasciatus, Notemigonus chrysoleucas, Ictalurus furcatus, I. punctatus, I. melas, Micropterus salmoides, Lepomis microlophus, L. megalotis, L. cyanellus, L. auritus, L. macrochirus, Pomoxis annularis, and P. nigromaculatus.

Astyanax fasciatus in Texas is limited to the Tamaulipan and Chihuahuan biotic provinces except where introduced (Hubbs, 1957). It has been found in the Colorado River (Tilton, 1961), Guadalupe (Hubbs, Kuenhe and Ball, 1952), San Marcos (Jurgens, 1951), and Rio Grande (Trevino, 1955). The records taken from the Navasota (TCWC 1183) probably represent a bait release.

Other species reach their eastern limits at or near the Navasota drainage. Campostoma anomalum apparently reaches its southeastern limits in the southeastern Navasota drainage. It has been reported from the Red River and Trinity River systems of northeast Texas and in the Brazos River above and below the mouth of the Navasota River. One specimen is labeled from the San Jacinto drainage (TCWC M-3-e-7) but data for collector and exact locality were lacking.

Fundulus olivaceous (Thomerson, 1967) and Notropis atrocaudalis apparently reach their western limits in the Navasota drainage (Hubbs, 1957; TCWC).

"Amia calva, Esox americanus,..., and Aphredoderus sayanus as well as N. fumeus reach western limits near (the Oak-Hickory-Blackland prairie line)" (Hubbs, 1957). This line runs across the northern third of the drainage. Amia calva is found along the coast to the Colorado drainage.

Hubbs says Etheostoma chlorosomum, Opsopoeodus emiliae and Lepisosteus spatula reach their western limits at about the eastern crosstimbers and Edwards Plateau—Blackland Prairie line. L. spatula extends throughout the Tamaulipan of Texas and O. emiliae occupies all of the Tamaulipan, except the Rio Grande River. E. chlorosomum is absent from the Tamaulipan (Hubbs, 1957).

The western limits of the ranges of Lepomis marginatus, L. symmetricus and Etheostoma parvipinne correspond with the western limit of the mixed Pine-Oak region which is at the eastern edge of the Navasota drainage. L. symmetricus is found on the coast west to the Colorado drainage in Matagorda and Fayette Counties (Hubbs, 1957; Tilton, 1961).

One specimen of Ictiobus niger was taken in Lake Springfield in the northern third of the drainage. It is an inhabitant of large rivers, sloughs and ox bows from the Great Lakes to Mexico (Moore, 1968). Hubbs and Lagler (1941) give the range as extending from eastern Nebraska and Minnesota to Lake Michigan and from Lake Erie to

the Ohio Valley south through the central Mississippi lowlands to the Gulf coast and Mexico. It has been reported from the Osage River in Missouri, the Arkansas River drainage in Oklahoma and San Pedro, Coahuila, Mexico (Hubbs and Ortenburger, 1929; Hubbs, 1930). It was reported from the Neosho River in Oklahoma (Branson, 1967), the Poteau River in Oklahoma and Arkansas (Cross and Moore, 1952). Baughman (1950) and Knapp (1953) gave no distribution for this fish in Texas, saying only that it was rare in Texas. Richey (1936) reported it from a lake in the Navasota floodplain in an unpublished report on fishes of southeast Texas. I. niger was reported from the Bosque River in a survey of that river system (Alexander, 1940). No published record could be found that indicates this species has been taken from other parts of the Brazos River drainage, or from east Texas south of the Red River system or east of the Sabine River.

Notropis venustus (Hubbs and Strawn, 1956), Ictalurus natalis, Lepomis punctatus, and Percina sciera are found in the Texan-Austroriparian, and Balconian biotic provinces in Texas (Hubbs, 1957). P. sciera is absent from the Nueces system and along the coast. N. buchanani also occupies this area.

According to Hubbs (1957), Noturus gyrinus, Fundulus notatus and Micropterus punctulatus occupy the Texan and Austroriparian, in Texas. Lepisosteus oculatus, Dorosoma petenensis and Etheostoma gracile occupy this area as well as the Tamaulipan. E. gracile is absent in the Rio Grande drainage.

Erimyzon oblongus has been reported from Austroriparian drain-

ages (Hubbs, 1957; Laswell, 1968).

Minytrema melanops is reported from north of a line between Fort Worth to Houston but not south of it (Hubbs, 1954; 1957). It is reported from the Llano River in west Texas (TNHC; TCWC) and in Cummins Creek in the Colorado drainage (Tilton, 1961).

Lepomis humilis ranges through the Kansas, Texas, and Austroriparian and is also found in the Llano uplift of the Balconian province of Texas (Hubbs, 1957).

Pimephales promelas reaches east to the Blackland Prairie-Oak-Hickory line, but is absent from the Balconian province (Hubbs, 1957).

An unnamed species of Percina similar to Percina caprodes is found in the Navasota River. The range of this species is unknown.

According to records in the Texas Cooperative Wildlife Collection, Hybognathus nuchalis apparently reaches its western limits close to the Navasota and Brazos drainages.

CONCLUSIONS

The fauna of the Navasota River drainage is different from that of other parts of the Brazos River drainage. It contains some components found only in Austroriparian drainages, while components found commonly in the Brazos and Colorado drainages are absent or found rarely in scattered localities in the Navasota River drainage. The western limits of several fishes are at or near the Navasota drainage. This caused Knapp (1953) to conclude that the Navasota fauna should be discussed with more eastern drainages rather than with the rest of the Brazos. These fishes, he believed, are present due to immigration from the north and east and the muddy waters of the Brazos keeps these eastern fishes confined to the Navasota drainage.

Knapp's ideas concerning this difference in faunas are supported in part by Darlington's idea (1957) that the fish fauna of a region of transition between two biotic provinces will show progressive additions and subtractions from each fauna as the transitory region is crossed. The Navasota River as mentioned in the introduction, is located in such a region. Generally, those fishes associated with more eastern or Austroriparian streams thin out or disappear from collections toward the western boundary of the drainage. The number of species is most numerous in the southeast drainage and channel. The fewest species occur in the northwestern part of the Navasota drainage where it drains part of the Blackland Prairie.

Another hypothesis to explain the eastern affinities of the Navasota fish fauna would involve stream piracy. Stream piracy occurs

when the headwaters of one stream system "pirates" or "captures" the headwaters of an adjacent stream system by headward erosion of its channel into the channels of the adjacent drainages. The Navasota drainage is the sort of area where stream piracy can easily occur.

Dr. Alan Lohse, of the geology department, of the University of Houston, has informed us that the U.S.G.S. topographic sheets of this region indicate headwater erosion by the tributary streams of the Navasota River along an escarpment, the Kisatchie Bajada. He says there are several apparent "wind gaps" along the eastern limits of the drainage. These "gaps" indicate capture by the Navasota of tributaries of the San Jacinto and Trinity tributaries (personal communication). Fishes in these captured headwaters could have spread through the capturing streams to other streams in the Navasota drainage in times of high water and flooding.

Possible Changes in the Navasota River Fish Fauna as a Result of the Proposed Impoundments

The building of the proposed dams and the resultant reservoirs is certain to cause some changes in the local fish fauna. Populations of riffle-dwelling and other lotic fishes will suffer as the reservoir fills and flowing streams are replaced by lakes. Many gravel-riffles and sandbar areas will be either inundated or destroyed by construction. Fishes such as Percina sciera which frequent these riffle areas face probable extermination in this area. Population of several smaller fishes such as Notropis lumeus, N. shumardi, N. buchanani, Hybognathus nuchalis, Noturus gyrinus, Etheostoma chloro-

somum, and E. gracile which were found almost exclusively in lotic habitats, will probably suffer.

Alterations of the river channel below the dam at river mile 24.1 may alter the Holland-Spring Creek drainage and may cause the disappearance of the most southeastern population of Campostoma anomalum recorded from Texas.

The most abundant species in gill net sets in Lake Springfield were Dorosomum cepedianum, Pomoxis annularis, and Ictiobus bubalus in that order. Lepomis megalotis, L. humilis, and L. macrochirus all were very numerous in seine collections. L. megalotis was especially common in shallow water during breeding season. The only darter taken in Lake Springfield was the undescribed logperch which apparently readily adapts to a lentic environment. Micropterus salmoides and Aplodinotus grunniens were also common in this reservoir.

It is therefore probable that these latter species will become more numerous as the species less well adapted to a lentic environment disappear from areas flooded by the filling of the reservoir. The resulting reservoir will probably develop a large population of ictalurids and centrarchids which are widely sought by fishermen. As the lakes mature the fauna will also develop large populations of various species of Lepisosteus, as well as Cyprinus carpio and Ictiobus bubalus which are common in large reservoirs in this area.

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APPENDICES

Appendix A.-List of Collecting Localities. Federal Highways are indicated by U. S. and highway number, as U. S. 84. State highways are indicated by Texas and highway number, as Texas 90. Farm to market roads are indicated by FM and road number, as FM 249. Robertson County is indicated by Robert. Limestone County is indicated by Limes. Freestone County is indicated by Frees.

Appendix A.-List of Collection sites

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
1	Navasota R. 2 mi S Texas 90	Brazos Grimes	30-23-43	96-08-54	sand-mud	<12	7/29/67	10
2	Navasota R. on Texas 90	do	30-22-00	96-08-30	sandstone and sand	do	7/28/67 7/28/68	22
3	Navasota R. on Texas 6	do	30-25-05	96-06-24	mud	do	7/28/67 10/3/67	7
4	Pothole aside locality 3	Brazos	do	do	do	-	7/17/68	7
5	Borrow pit on Texas 6, 3 mi N of Navasota	do	30-25-36	96-06-36	do	-	10/31/67 3/17/68 3/22/68	11
6	Spring Creek on Texas 90	Grimes	30-23-54	96-02-24	sand, gravel, bedrock	25	12/2/67 1/13/68 3/2/68 6/4/68	16
7	Branch of Spring Creek, Purvis Ranch, 3/4 mi S Texas 90	do	30-25-38	96-01-54	sand, rock	25	6/4/68	5
8	Spring Creek 1 mi S Texas 90	do	30-25-50	96-01-30	rock	24	3/2/68 6/4/68	11
9	Thomas Creek, low water crossing, 2 mi S Anderson	do	30-26-55	96-00-03	mud	17	3/3/68	3

Appendix A.-(Cont.)

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
10	Honey Creek on Texas 90	do	30-28-16	96-00-28	sand	28	12/2/67	5
11	Honey Creek 1-1/2 mi W Anderson on FM 149	Grimes	30-29-33	96-00-28	do	35	6/19/68	5
12	Nebbits Creek on FM 149, E Anderson	do	30-29-53	95-58-24	do	do	do	5
13	Upshur Branch on FM 2154, 1-1/2 mi S Millican	Brazos	30-27-11	96-10-30	do	27	7/17/68	9
14	Branch of Turkey Creek 6 mi N Navasota, 1 mi S FM 244	Grimes	30-05-08	96-05-52	sand, mud	15	1/13/68	8
15	Pine Creek N Anderson	do	30-30-55	96-00-18	sand	36	6/6/68	5
16	Rocky Creek 5 mi N Anderson on FM 249	do	30-30-34	96-05-54	mud	6	12/2/67	14
17	Rocky Creek 3.8 mi N Anderson	do	30-30-34	96-00-01	do	11	12/2/67	10
18	Rocky Creek 1 mi S Roans Prairie on Texas 90	do	30-34-29	95-56-54	sand	30	4/26/68	10
19	Peach Creek on Texas 6, 6 mi S College Station	Brazos	30-30-54	96-12-18	do	17	7/17/68	17

Appendix A.-(Cont.)

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
20	Peach Creek 1 mi S Carlos on FM 249	Grimes	30-34-12	96-03-55	mud, sand	7	12/2/67	7
21	Potholes at Sulphur Springs	Brazos Grimes	30-34-14	96-10-00	mud	-	3/3/68 6/19/68 7/9/68	30
22	Navasota R., Sulphur Springs 11 mi S College Station	Brazos Grimes	30-35-55	96-05-50	mud, sand, gravel	>12	5/24/67 7/29/67 11/3/67 3/22/68 6/19/68 6/27/68 7/19/68 7/30/68	33
23	Rock Lake Creek 1 mi W Carlos on Texas 30	Grimes	30-35-55	96-10-00	bedrock	25	10/27/67	3
24	Sulphur Creek 2.7 mi N Roans Prairie on Texas 90	do	30-38-12	95-57-18	sand, mud	15	4/26/68	6
25	Spring Creek on Highway 6, 6 mi S College Station	Brazos	30-34-00	96-15-42	mud, sand	17.5	3/23/68	11
26	Cat Creek on Texas 90, 1 mi N Singleton	Grimes	30-39-46	95-57-35	sand, gravel	37	6/20/68	12

Appendix A.-(Cont.)

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
27	Navasota R. at Texas 30, 8 mi N Carlos	Grimes	30-36-22	96-10-42	mud	<12	10/27/67	9
28	Pothole by Navasota R. at Texas 30	Brazos	30-36-25	96-10-42	do	-	do	4
29	Small borrow pit near Carter's Creek on Lake Placid Road, 6 mi E College Station	do	30-35-54	96-15-03	do	-	10/17/67	10
30	Hog Creek off FM 244	Grimes	30-38-42	95-05-30	sand	13.5	6/20/68	11
31	Country Club Lake on South College Ave., Bryan	Brazos	30-38-38	95-21-36	mud	18	7/4/68	7
32	Wickson Creek 5 mi E on Weedon Road	do	30-41-46	96-13-00	sand, mud	13	11/2/67	11
33	Carter's Creek by Junction off FM 158 and FM 1179	do	36-40-11	96-19-13	mud	15	7/4/68	14
34	Old River channels Navasota R. at Democrat's Crossing	Brazos Grimes	30-40-16	96-10-30	do	<12	10/27/67	7
35	Wickson Creek and slough 1/4 M off FM 1179, 8 mi E Bryan	Brazos	36-43-16	96-15-00	sand, mud	13	1/6/68 7/4/68	21
36	Bull Creek 10 mi N Carlos	Grimes	30-44-00	96-05-00	mud, sand	17	6/19/68	7

Appendix A.-(Cont.)

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
37	Bowman Creek on FM 1179, 10 mi E Bryan	Brazos	30-44-54	96-13-54	mud-under culvert	17.8	1/6/68	8
38	Wickson Creek on U.S. 190, 6 mi NE Bryan	do	30-44-39	96-18-54	sand, mud	17.5	3/8/68	2
39	Mathis Creek at U.S. 190, 7 mi NE Bryan	do	30-45-25	96-17-45	mud	15	do	1
40	Cedar Creek at U.S. 190, NE Bryan	do	30-49-59	96-12-52	sand gravel	11	do	16
41	Slough off Old Cedar Creek 400 yards E Locality #40	do	do	do	mud	-	do	7
42	Navasota R. at U.S. 190 near Easterly	Brazos Grimes	30-52-11	96-11-24	do	<12	8/4/67 2/23/68	12
43	Mathis Creek FM 974	Brazos	30-40-27	96-20-06	do	15	11/3/67	12
44	Spark Creek at FM 974	do	30-51-56	96-18-38	do	do	do	10
45	Navasota R. at Twin Lake Ranch	Madison	30-54-38	96-12-42	do	<12	7/23/68	17
46	Pothole on Twin Lake Ranch	do	30-55-15	96-11-45	do	-	do	25

Appendix A.- (Cont.)

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
47	Sassafras Lake on Twin Lake Ranch	Madison	30-55-00	96-12-00	mud	-	7/23/68	10
48	Bog on Twin Lake Ranch	do	30-54-38	96-12-42	mud detritus	-	9/31/68	2
49	Twin Lake on Twin Lake Ranch	do	30-55-10	96-12-48	mud	-	8/1/68	14
50	Cedar Creek on OSR near Wheelock	Robert.	30-54-11	96-21-30	sand	11	11/4/67 12/16/67	14
51	Little Cedar Creek at FM 974	Brazos	35-35-38	96-16-00	do	15	11/3/67	8
52	Navasota R. at OSR	Brazos Madison Robert. Leon	30-58-33	96-14-30	sand, mud	<12	8/5/67 12/16/67	17
53	Navasota R. overflow beside #52	Brazos	do	do	mud	do	11/4/67	2
54	Pothole beside Navasota R. at #52	do	do	do	do	-	12/16/67	5
55	Devil's Jump Creek at FM 1946, 2 mi N OSR	Robert.	35-55-52	96-17-01	sand, gravel	34	2/9/68	9

Appendix A.-(Cont.)

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
56	Beneath culvert 2.1 mi N locality #55 on FM 1947	Robert.	31-00-36	96-18-02	sand, gravel	34	2/9/68	
57	Branch of Cobb Creek on FM 1940	do	31-03-36	96-19-50	do	35	12/16/67	
58	Cedar Creek, second crossing at FM 46 below Franklin	do	31-58-47	96-26-09	do	23	12/16/67 5/11/68	1
59	Running Creek on FM 3	Leon	31-00-36	96-14-20	sand	16.5	2/23/68 5/3/68	1
60	Normangee City Lake	do	31-01-16	96-12-24	mud	-	5/3/68 5/10/68	1
61	Running Creek below Normangee City Lake	do	do	do	sand	16.5	5/4/68	
62	Camp Creek on FM 1940	Robert.	30-03-06	96-19-51	do	15	11/4/67	
63	Camp Creek Lake behind dam	do	31-03-42	96-17-14	sand, gravel	-	2/10/67	1
64	Clear Creek at FM 3	Leon	30-07-15	96-14-39	gravel, sand	15	2/11/68	2
65	Clear Creek at FM 977	do	30-07-50	96-14-00	sand	do	2/24/68	

Appendix A.-(Cont.)

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
66	Headwaters of Camp Creek 2 mi S New Baden	Robert.	31-02-15	96-24-22	sand, gravel	24	7/3/68	13
67	South Mineral Creek 1 mi N New Baden	do	31-03-58	96-26-31	mud	15	2/10/68	4
68	North Mineral Creek 6 mi N New Baden	do	31-07-10	96-27-54	gravel, sand	30	7/3/68	15
69	Mineral Creek 2.5 mi N Easterly	do	31-08-08	96-23-12	sand	15	2/1/68	12
70	Pothole by Navasota R. at U.S. 79	Leon	31-10-10	96-17-58	mud	-	7/11/68	17
71	Brushy Creek on FM 977, 4 mi S Marquez	do	38-40-34	96-16-21	sand, gravel	11	2/11/68	11
72	Duck Creek on FM 2096 S Bald Prairie, 6 mi NW Easterly	Robert.	31-10-26	96-25-09	sand	15	7/11/68	14
73	Navasota R. at Texas 7	do	31-15-17	96-19-47	do	<12	do	18
74	Willow Creek on Texas 7 W Navasota R.	do	31-16-18	96-24-25	mud	14	do	5
75	Lynn Creek on FM 3	Frees.	31-25-26	96-14-42	sand, gravel	20+	7/4/68	13

Appendix A.-(Cont.)

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
76	Old Channel and ditch along road by Navasota R. at edge of Oletha Oil Field	Limes.	31-26-20	96-22-36	mud	<12	7/11/68	10
77	Rocky Creek at Texas 14, 4 mi S Groesbeck	do	31-30-19	96-29-27	bedrock	14	2/17/68 4/5/68	5
78	Middle Creek on Texas 164, 6.5 mi E Groesbeck	do	31-30-42	96-25-43	sand, gravel	25	2/2/68	5
79	Navasota R. at Texas 164, 5 mi E Groesbeck	do	30-30-45	96-27-02	sand, mud	<10	6/68 7/20/68	14
80	Old River channel 4.8 mi E Groesbeck	do	30-30-47	96-27-26	mud	do	2/2/68	5
81	Frost Creek on Texas 14.1 mi S Groesbeck	do	31-30-39	96-32-38	do	15	4/5/68	4
82	Frost Creek 1/2 mi N Texas 164, 3-1/2 mi W Groesbeck	do	31-32-09	96-35-55	do	do	6/11/68	9
83	Plummers Creek 1 mi W Texas 34, 4 mi S Mexia	Frees.	31-37-43	96-28-40	sand	13	6/13/68	2
84	Branch Plummers Creek 3 mi S Springfield community	do	31-37-22	96-29-31	mud	15	do	4

Appendix A.-(Cont.)

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
85	Cat Creek 1 mi S Teague on FM 80	Frees.	31-35-06	96-17-09	mud	15	7/9/68	10
86	Holman Creek on FM 1365	do	31-37-44	96-19-42	sand	25	do	4
87	Branch of Prairie Creek E Shiloh	do	31-36-48	96-24-16	mud	15	7/11/68	8
88	Springfield Lake, by concession stand	Limes.	31-35-47	96-32-14	sand, gravel	-	12/21/67 4/4/68 6/11/68 7/11/68	17
89	Springfield Lake, 1 mi N concession stand	do	31-36-23	96-32-45	mud	-	4/4/68	7
90	Springfield Lake, 1/2 mi S across from concession stand	do	31-35-37	96-32-23	do	-	7/11/68	9
91	Baines Creek 4-1/2 mi WNW Groesbeck	do	31-33-23	96-35-06	sand	20+	4/5/68	6
92	Christmas Creek on FM 339	do	31-38-02	96-44-38	do	13.1	4/4/68	6
93	Baines Creek off Texas 164, NW Groesbeck	do	31-33-25	96-35-06	sand	15	6/11/68	3
94	Christmas Creek 3 mi SE U.S. 84, 11.7 mi WSW Mexia	do	31-37-39	96-38-33	sand, gravel	5	6/13/68	6

Appendix A.-(Cont.)

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
95	Christmas Creek on FM 1245	Limes.	31-37-58	96-39-12	mud, sand	13	4/5/68	8
96	Jacks Creek by Confederate Reunion Grounds	do	31-38-25	96-33-21	bedrock	13	6/11/68	10
97	Lake Mexia by concession stand	do	31-39-13	96-53-30	mud	-	12/21/67	12
98	Lake Mexia across from concession stand	do	31-39-58	96-35-30	do	-	12/22/67	4
99	Navasota R. at U.S. 84, 11.3 mi WSW Mexia	do	31-39-49	96-39-36	sand	<12	12/21/67 6/12/68	8
100	Old river channel 11 mi WSW Mexia on U.S. 84	do	31-39-54	96-39-16	mud	do	4/5/68	5
101	Navasota R. at FM 73, 6.7 mi NE Prairie Hill	do	31-42-06	96-43-21	sand	do	6/12/68	9
102	Culvert on FM 73, 200 yards SW locality #101	do	do	do	mud	-	do	6
103	Keitt Creek 1.5 mi E Navasota R.	do	31-44-07	96-45-06	do	17.5		12
104	Navasota R. at Texas 31, 1 mi NE Mt. Calm	Hill	31-46-19	96-52-26	do	<12	6/12/68	8

Appendix A.-(Cont.)

	Location	County	Lat	Long	Bottom	Gradient (ft/mi)	Date	Species
105	Headwaters, Navasota R., 1.5 mi NE Mount Calm	Hill	31-46-50	96-52-39	mud	<12	6/12/68	5

Appendix B.-Classification of specimens. Ordinal and familial names follow Greenwood et al. (1966). Species names follow Moore (1968). Notation for number of specimens is as follows: T=3. 3(1); 5(2). A total of three specimens were collected, one at locality 3 and 2 at locality 5.

APPENDIX B

Order-Amiiformes

Family-Amiidae

Amia calva Linnaeus. Bowfin. T=3. 21(1); 46(1); 49(1).

Order-Lepisosteiformes

Family-Lepisosteidae

Lepisosteus spatula (Lacépède). Alligator gar. T=8. 19(2); 21(1); 22(3); 46(1); 49(1).

Lepisosteus oculatus (Winchell). Spotted gar. T=36. 2(1); 4(1); 5(3); 21(3); 22(16); 46(4); 49(5); 60(1); 89(2).

Lepisosteus osseus (Linnaeus). Longnose gar. T=5. 5(1); 21(3); 49(1).

Order-Clupeiformes

Family-Clupeidae

Dorosoma cepedianum (Le Sueur). Gizzard shad. T=553. 2(13); 4(25); 16(1); 17(2); 21(16); 22(45); 32(1); 33(2); 35(1); 41(1); 46(32); 47(3); 49(11); 70(2); 73(12); 79(11); 88(245); 89(2); 90(103); 92(3); 96(21); 102(1).

Dorosoma petenense (Günther). Threadfin shad. T=74. 2(22); 4(30); 22(2); 46(20).

Order-Salmoniformes

Family-Esocidae

Esox americanus Gmelin. Redfin pickerel. T=47. 20(1);

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21(1); 26(1); 30(1); 58(5); 59(20); 60(9); 61(1); 63(3); 64(1); 69(4).

Order-Cypriniformes

Family-Cyprinidae

Cyprinus carpio Linnaeus. Carp. T=111. 2(2); 4(3); 5(1); 13(12); 19(3); 21(9); 22(15); 30(2); 33(11); 35(2); 36(1); 46(16); 49(1); 70(4); 71(18); 76(10); 90(1).

Notemigonus chrysoleucas (Mitchell). Golden shiner. T=492. 8(1); 12(5); 13(31); 14(7); 18(8); 19(12); 21(19); 22(43); 23(14); 24(5); 25(6); 26(11); 29(12); 30(1); 32(1); 33(25); 35(17); 36(13); 37(81); 38(2); 41(2); 43(4); 44(4); 46(34); 51(5); 55(2); 59(2); 63(1); 68(10); 69(9); 70(4); 72(1); 74(4); 75(2); 76(2); 81(3); 82(1); 88(10); 91(9); 93(5); 95(3); 96(30); 99(3); 100(3); 102(3); 104(20); 105(2).

Opsospoeodus emiliae Hay. Pugnose minnow. T=498. 1(2); 2(14); 19(1); 20(13); 22(156); 25(2); 28(1); 31(15); 33(3); 34(3); 40(15); 42(27); 45(150); 46(18); 47(10); 52(10); 53(10); 67(1); 70(4); 72(6); 73(13); 74(2); 88(13); 97(7); 100(2).

Notropis fumeus Evermann. Ribbon shiner. T=1147. 2(33); 6(87); 8(4); 13(11); 17(1); 19(10); 22(210); 25(1); 26(1); 33(20); 40(9); 44(13); 45(1); 50(33); 58(571); 64(60);

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65(4); 66(1); 68(4); 69(1); 72(15); 75(57).

Notropis shumardi (Girard). Silverband shiner. T=76. 1(23); 3(16); 52(17); 79(20).

Notropis lutrensis (Baird and Girard). Red shiner. T=4356. 1(174); 2(193); 3(116); 6(218); 7(3); 8(124); 9(13); 10(382); 14(1); 15(7); 16(23); 17(60); 18(1); 19(14); 21(4); 22(403); 27(29); 31(332); 33(8); 42(244); 45(5); 52(921); 53(5); 59(2); 64(1); 66(15); 68(2); 69(2); 71(148); 72(6); 73(58); 76(2); 77(1); 78(2); 79(210); 80(22); 81(4); 88(316); 91(5); 92(17); 94(5); 96(96); 97(4); 101(42); 103(17); 104(15).

Notropis venustus (Girard). Blacktail shiner. T=309. 40(14); 50(9); 58(194); 64(66); 65(22); 66(3); 72(1).

Notropis atrocaudalis Evermann. Blackspot shiner. T=392. 6(3); 8(10); 9(1); 10(9); 13(13); 19(7); 26(13); 44(5); 50(15); 55(41); 57(123); 58(140); 64(5); 66(5); 68(2).

Notropis buchanani Meek. Ghost shiner. T=106. 1(6); 2(66); 22(7); 40(5); 42(8); 45(14).

Hybognathus nuchalis Agassiz. Silvery minnow. T=144. 1(1); 2(8); 6(4); 13(7); 14(5); 19(16); 21(16); 22(34); 30(1); 33(31); 36(2); 45(5); 46(2); 68(1); 73(11).

Pimephales vigilax (Baird and Girard). Bullhead minnow. T=639. 1(5); 2(55); 3(14); 6(42); 7(4); 8(40); 16(7);

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17(1); 22(25); 27(5); 33(8); 40(25); 42(32); 45(10); 50(1); 52(142); 58(20); 64(57); 65(14); 71(3); 73(17); 77(1); 79(18); 80(3); 88(87); 96(1); 99(2).

Pimephales promelas Rafinesque. Bluntnose minnow. T=1. 31(1).

Campostoma anomalum (Rafinesque). Stoneroller. T=55. 6(14); 7(1); 8(12); 12(3); 15(11); 58(14).

Family-Catostomidae

Ictiobus niger (Rafinesque). Black buffalofish. T=1. 90(1).

Ictiobus bubalus (Rafinesque). Smallmouth buffalofish. T=28. 5(4); 19(1); 21(3); 22(5); 49(3); 76(1); 89(3); 90(5); 98(3).

Carpiodies carpio (Rafinesque). River carpsucker. T=19. 6(1); 8(1); 16(1); 22(6); 35(1); 49(7); 66(1); 79(1).

Minytrema melanops (Rafinesque). Spotted sucker. T=9. 32(1); 40(1); 46(1); 58(2); 64(2); 68(2).

Erimyzon oblongus (Lacépède). Creek chubsucker. T=7. 60(4); 63(3).

Order-Siluriformes

Family-Ictaluridae

Ictalurus punctatus (Rafinesque). Channel catfish. T=57. 2(7); 3(4); 18(2); 21(3); 22(14); 45(4); 46(1); 49(3);

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52(4); 73(5); 79(2); 88(2); 90(3); 98(3).

Ictalurus furcatus (LeSueur). Blue catfish. T=3.
2(1); 3(1); 22(1).

Ictalurus melas (Rafinesque). Black bullhead. T=176.
1(1); 5(25); 8(1); 13(2); 18(21); 21(15); 22(23); 24(2); 32(1); 37(36); 41(5); 46(16); 59(1); 62(1); 68(5); 69(1); 70(4); 71(1); 75(1); 81(2); 89(4); 92(1); 95(4); 97(1); 101(1); 103(1).

Ictalurus natalis (LeSueur). Yellow bullhead. T=116.
21(35); 22(45); 46(2); 94(15); 104(19).

Pylodictis olivaris Rafinesque. Flathead catfish. T=41.
2(1); 21(30); 22(8); 46(1); 49(1).

Noturus gyrinus (Mitchell). Tadpole madtom. T=23. 6(3); 21(1); 22(5); 35(1); 40(1); 46(5); 50(1); 52(1); 60(2); 75(1); 76(2);

Order-Percopsiformes

Family-Aphredoderidae

Aphredoderus sayanus (Gilliams). Pirateperch. T=33.
6(1); 35(1); 46(16); 50(3); 51(1); 58(2); 59(2); 63(1); 70(1); 71(5).

Order-Atheriniformes

Family-Cyprinodontidae

Fundulus notti (Agassiz). Starhead topminnow. T=100.

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59(66); 60(14); 61(20).

Fundulus notatus (Rafinesque). Blackstripe topminnow.

T=21. 6(12); 42(1); 47(2); 63(1); 66(4); 101(1).

Fundulus olivaceous (Storer). Blackspotted topminnow.

T=501. 10(6); 15(5); 16(1); 17(1); 18(24); 19(4); 21(1); 22(1); 24(1); 25(21); 26(7); 29(6); 30(1); 32(12); 35(4); 40(4); 42(2); 45(1); 46(1); 47(34); 50(25); 51(23); 52(1); 57(45); 58(72); 59(7); 61(1); 64(50); 65(9); 66(6); 67(1); 68(6); 69(9); 70(7); 72(1); 75(103); 84(1); 94(1).

Family-Poeciliidae

Gambusia affinis (Baird and Girard). Mosquitofish.

T=6620. 1(176); 2(182); 3(93); 4(107); 5(70); 6(48); 10(380); 11(25); 13(15); 14(33); 15(7); 16(250); 17(211); 18(27); 19(93); 20(302); 21(755); 22(863); 23(43); 24(8); 25(3); 26(119); 27(30); 28(78); 29(17); 30(30); 31(141); 32(48); 33(4); 34(284); 35(105); 36(22); 37(43); 39(4); 40(1); 42(66); 43(159); 44(10); 45(99); 46(225); 47(8); 48(44); 50(2); 51(30); 52(118); 54(65); 57(78); 58(3); 59(37); 60(7); 63(7); 64(1); 65(1); 66(1); 68(2); 69(19); 70(78); 71(31); 72(2); 73(205); 74(40); 75(68); 76(57); 77(1); 79(163); 80(5); 82(22); 83(1); 84(1); 86(4); 87(12); 88(39); 91(1); 92(1); 93(3); 94(42); 95(10); 97(4); 99(16); 100(6); 101(40); 102(69); 103(18); 104(80); 105(2).

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Order-Perciformes

Family-Centrarchidae

Micropterus salmoides (Lacépède). Largemouth bass. T=205. 5(3); 8(2); 12(6); 16(1); 18(1); 19(15); 21(5); 22(9); 26(5); 29(2); 30(4); 32(1); 36(5); 37(2); 44(2); 47(7); 49(2); 50(1); 58(2); 59(2); 60(13); 62(2); 64(1); 66(2); 68(8); 70(2); 72(1); 73(7); 75(10); 76(2); 79(8); 81(1); 82(1); 85(2); 86(5); 87(3); 88(26); 89(2); 96(2); 97(8); 101(1); 104(6); 105(16).

Micropterus punctulatus (Rafinesque). Spotted bass. T=10. 27(1); 40(1); 42(1); 64(3); 73(4).

Chaenobryttus gulosus (Cuvier). Warmouth sunfish. T=260. 2(1); 5(3); 16(5); 18(4); 20(1); 21(10); 22(13); 25(1); 27(1); 29(17); 31(5); 34(3); 35(9); 37(2); 40(1); 41(1); 42(2); 44(2); 45(18); 46(39); 49(2); 51(3); 52(9); 54(13); 55(1); 58(2); 59(4); 60(2); 63(1); 66(1); 68(1); 70(17); 72(2); 73(6); 75(11); 76(1); 79(4); 80(1); 82(5); 87(31); 88(3); 95(2); 97(1).

Lepomis cyanellus Rafinesque. Green sunfish. T=552. 2(1); 6(10); 7(31); 8(11); 9(3); 10)14); 11(2); 12(7); 13 (3); 14(3); 15(11); 16(20); 17(12); 18(4); 20(2); 21(9); 22(5); 23(2); 24(2); 25(1); 26(7); 30(1); 31(32); 33(5); 35(8); 36(5); 37(44); 38(1); 42(2); 43(2); 44(10);

APPENDIX B

46(7); 48(1); 50(9); 51(5); 52(2); 55(1); 57(2); 58(16); 62(2); 63(1); 64(1); 66(3); 68(3); 69(8); 70(1); 71(1); 72(5); 73(8); 74(2); 75(26); 78(20); 79(7); 82(13); 83(1); 87(8); 88(6); 91(9); 92(2); 93(3); 94(1); 95(1); 96(2); 97(1); 99(27); 100(23); 101(11); 102(7); 103(9); 104(23); 105(3).

Lepomis symmetricus Forbes. Bantam sunfish. T=15. 35(1); 59(8); 60(6).

Lepomis punctatus (Valenciennes). Spotted sunfish. T=12. 59(2); 60(10). This fish was also reported from locality 63, Camp Creek Lake, by other collectors.

Lepomis microlophus (Gunther). Redear sunfish. T=55. 5(1); 59(7); 60(27); 62(6); 63(2); 68(1); 75(5); 87(5); 88(1).

Lepomis marginatus (Holbrook). Dollar sunfish. T=2. 35(2).

Lepomis megalotis (Rafinesque). Longear sunfish. T=593. 1(2); 2(10); 4(3); 5(3); 6(48); 7(10); 14(17); 16(16); 17(2); 19(1); 21(4); 22(42); 25(4); 26(7); 27(10); 29(7); 33(5); 34(6); 40(52); 41(1); 42(21); 45(1); 50(5); 52(43); 54(18); 55(4); 58(31); 64(27); 65(2); 66(22); 67(1); 68(4); 70(2); 71(1); 72(1); 73(8); 75(24); 79(1); 86(13); 87(1); 88(80); 90(1); 96(6); 97(22); 99(1); 101(2); 104(1).

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Lepomis humilis (Girard). Orangespotted sunfish. T=242.
2(9); 7(1); 16(1); 17(2); 20(2); 21(1); 22(10); 27(1);
32(1); 42(24); 45(2); 46(21); 47(2); 50(17); 52(7); 54(20);
62(2); 69(1); 73(16); 79(15); 80(5); 82(9); 88(58); 91(1);
95(1); 96(2); 97(4); 99(1); 101(2); 102(4).

Lepomis macrochirus Rafinesque. Bluegill sunfish. T=1178.
1(1); 2(7); 3(3); 6(1); 8(2); 12(2); 13(1); 16(32); 17(6);
18(3); 19(8); 20(32); 21(2); 22(31); 24(3); 25(18); 26(10);
27(12); 28(6); 29(48); 30(1); 31(24); 32(5); 33(5); 34(81);
35(17); 37(6); 40(34); 41(33); 42(17); 44(2); 45(1);
46(37); 47(7); 50(5); 51(2); 52(114); 54(73); 55(1);
58(11); 59(37); 60(26); 63(42); 65(5); 66(2); 67(5); 68(7);
69(6); 70(2); 72(1); 73(6); 75(31); 76(50); 77(20); 79(17);
81(2); 82(7); 84(4); 86(6); 87(23); 88(77); 89(3); 90(3);
91(1); 95(4); 96(1); 97(78); 98(3); 101(1); 103(1); 105(2).

Pomoxis nigromaculatus LeSueur. Black crappie. T=5.
21(3); 32(1); 34(1).

Pomoxis annularis Rafinesque. White crappie. T=420.
2(9); 4(13); 5(6); 19(2); 21(3); 22(76); 25(2); 27(1);
28(17); 29(29); 32(1); 33(1); 34(7); 35(1); 41(18); 42(1);
44(1); 45(5); 46(2); 47(2); 49(14); 52(1); 60(1); 52(2);
70(19); 72(2); 73(36); 76(31); 77(1); 79(29); 82(1);
84(1); 88(8); 89(10); 90(15); 92(4); 95(1); 96(2); 97(6);

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98(2); 99(7); 100(5); 102(1).

Family-Elassomatidae

Elassoma zonatum Jordan. Banded pygmy sunfish. T=15. 20(9); 21(1); 54(2); 59(3).

Family-Percidae

Percina sciera (Swain). Dusky darter. T=60. 6(1); 22(1); 50(7); 52(5); 58(16); 64(7); 65(1); 71(21); 73(1).

Percina sp. Logperch. T=20. 22(4); 40(3); 45(2); 88(10); 97(1).

Etheostoma chlorosomum (Hay). Bluntnose darter. T=132. 2(13); 16(2); 21(1); 22(23); 25(1); 26(2); 29(1); 30(2); 40(21); 44(1); 45(24); 46(4); 47(2); 52(1); 55(1); 58(10); 64(1); 65(6); 69(1); 70(5); 73(2); 75(8).

Etheostoma parvipinne (Gilbert and Swain). Goldstripe darter. T=17. 55(1); 57(2); 64(1); 71(13).

Etheostoma gracile (Girard). Slough darter. T=205. 2(1); 6(1); 14(1); 16(4); 21(4); 22(7); 26(47); 29(1); 30(6); 33(1); 35(4); 36(2); 37(1); 43(4); 44(2); 46(1); 50(6); 51(6); 52(4); 55(14); 56(1); 57(3); 58(20); 59(3); 69(3); 70(11); 72(4); 73(14); 75(3); 78(1); 82(14); 87(6); 94(3).

Family-Sciaenidae

Aplodinotus grunniens Rafinesque. Freshwater drum. T=8. 45(3); 49(1); 88(1); 90(3).

Appendix B

Some species in the Texas Cooperative Wildlife Collection and recorded from the Navasota River drainage were not taken in this survey. These are listed below with their collection localities (station numbers refer to those used in this survey).

Astyanax fasciatus Banded tetra. Floodplain of the Navasota R. 6 mi N Bryan (probably near Station 42).

Hybopsis aestivalis Speckled chub. Station 22, 34.

Notropis amablis Texas shiner. Station 22.

Notropis texanus Weed shiner. Station 3.

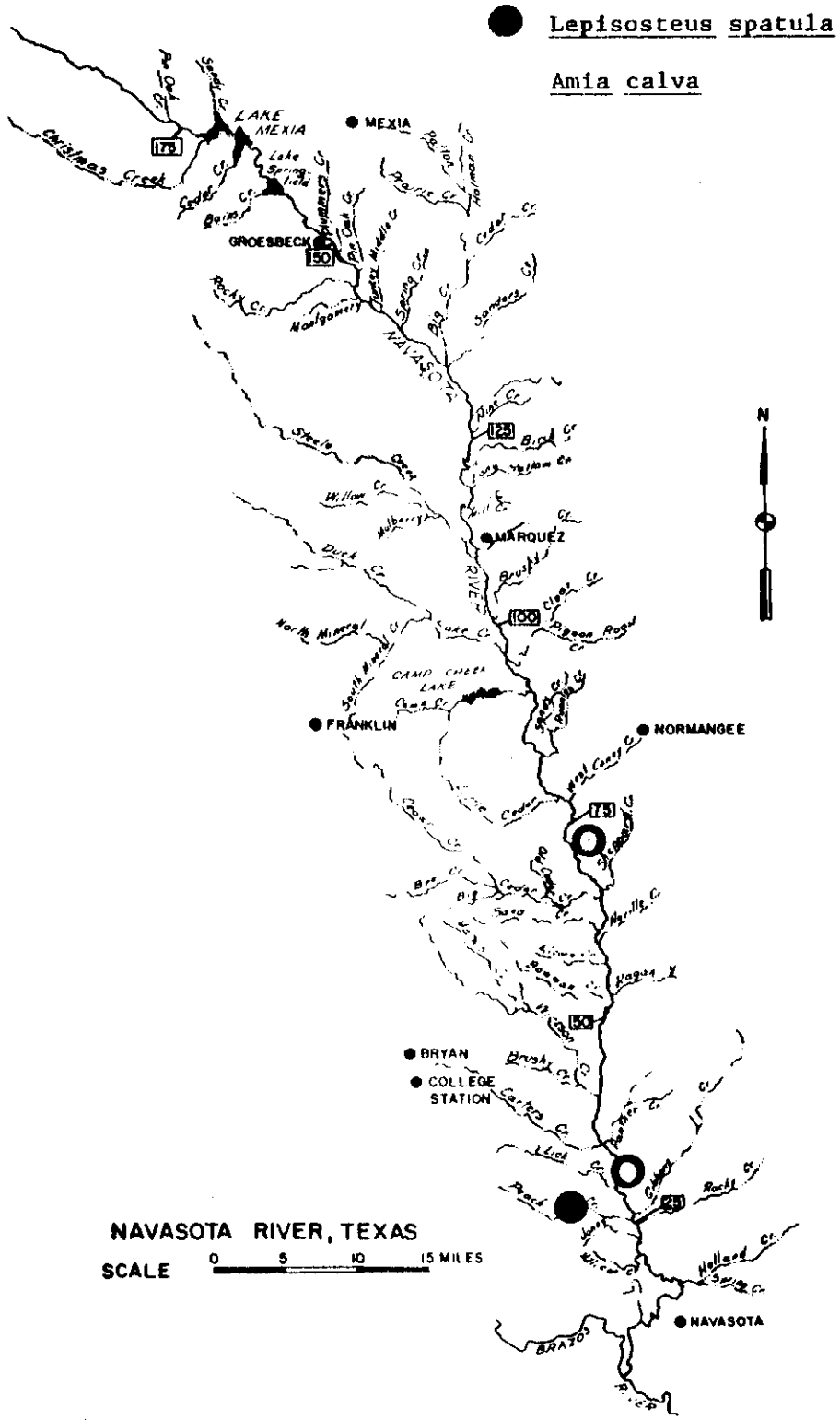
Notropis amnis Pallid shiner. Station 22.

Poecilia latipinna Sailfin molly. Roadside pond, 3 mi S College Station on Texas 6.

Labidesthes sicculus Brook silversides. Stations 19, 22.

Lepomis auritus Redbreast sunfish. Station 19.

Appendix C.-Species Distribution Maps. A black dot with a white center indicates that both species were taken from the same locality.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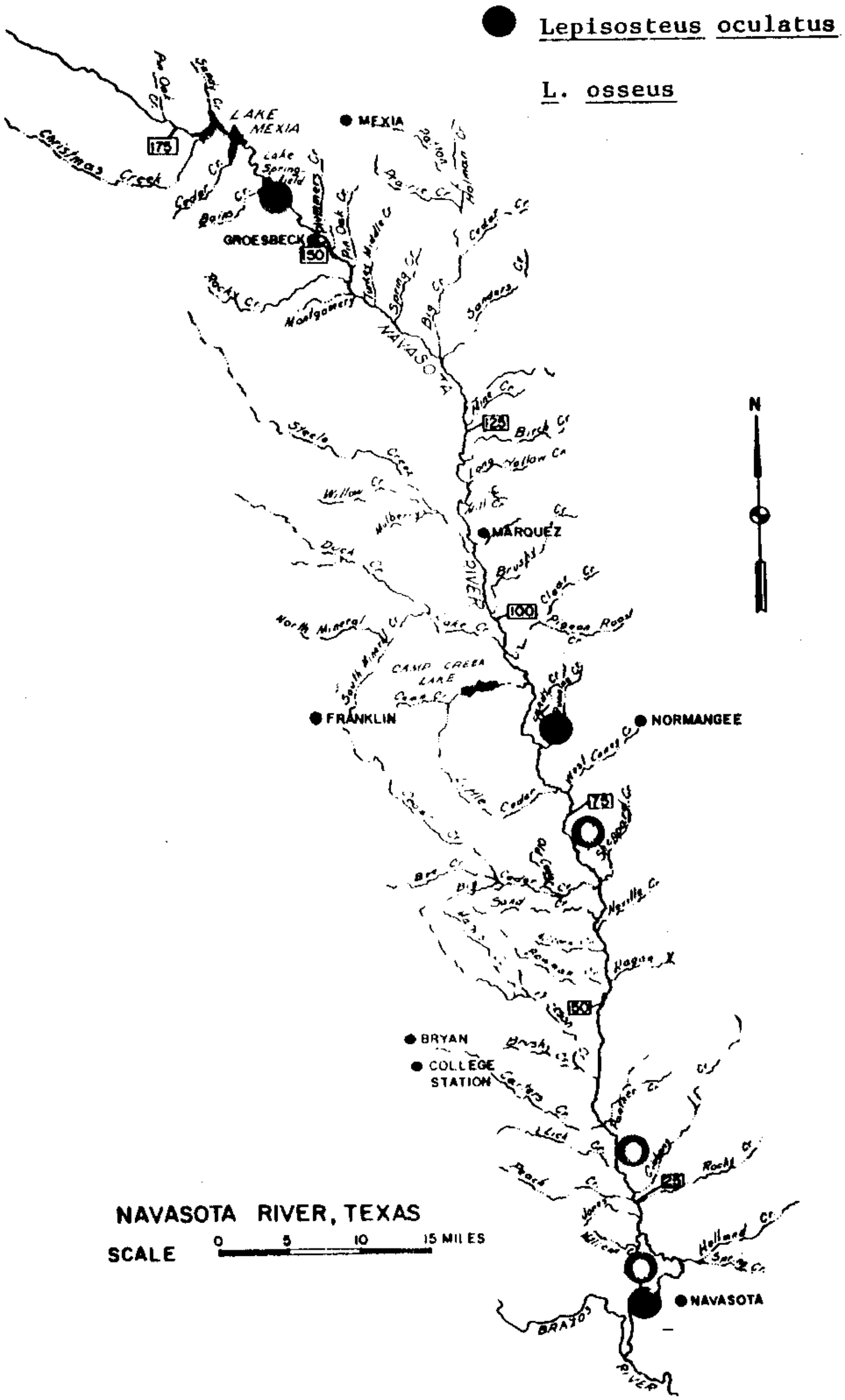
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
NAVASOTA RIVER, TEXAS
SCALE
0 5 10 15 MILES
N



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L. osseus
LAKE MEXIA
MEXIA
GROESBECK
NAVASOTA
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
BRAZOS RIVER
Christmas Creek
CAMP CREEK LAKE
N
NAVASOTA RIVER, TEXAS
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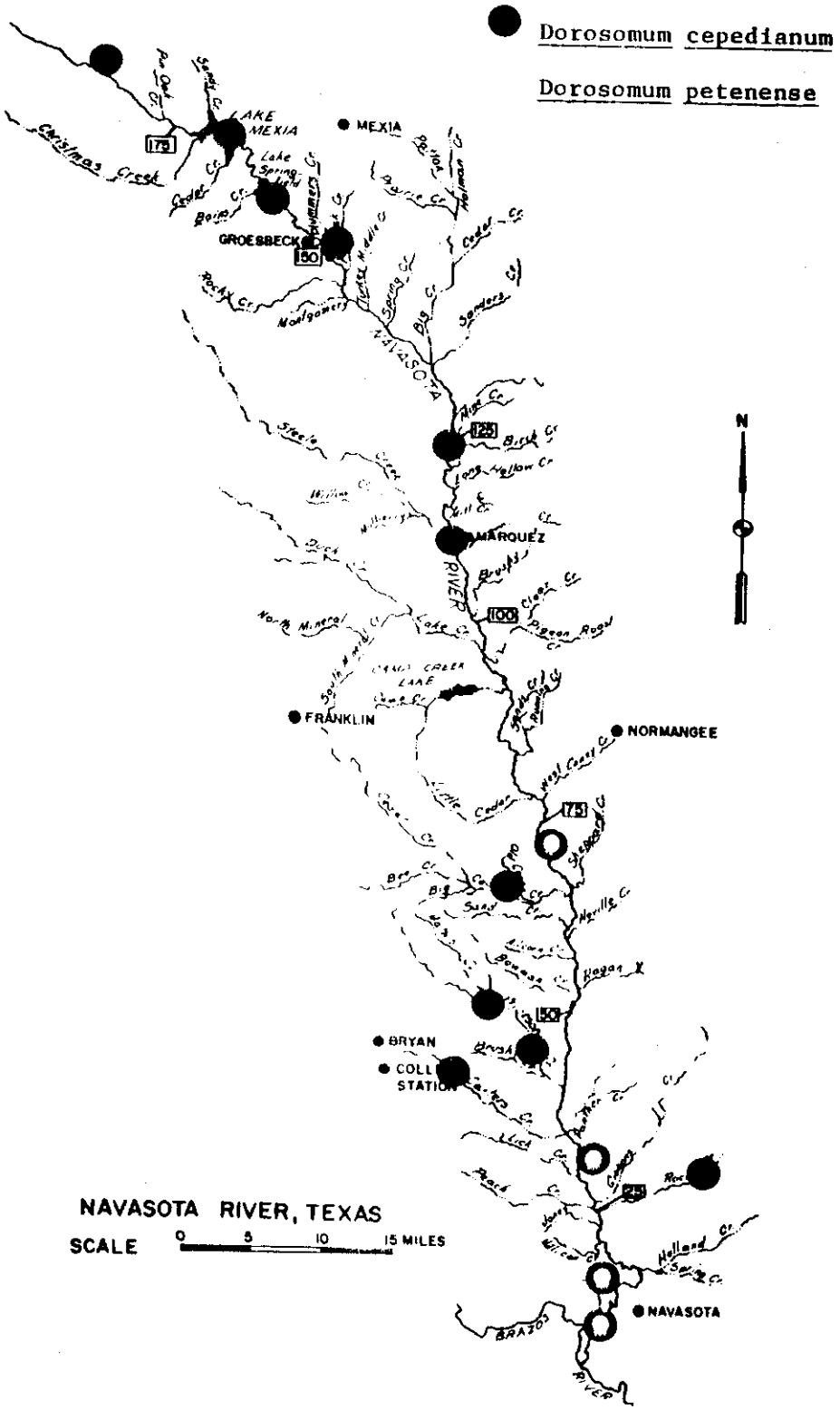
150
125
100
75
50
25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MARQUEZ
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NAVASOTA
NAVASOTA RIVER
BRAZOS RIVER
N
NAVASOTA RIVER, TEXAS
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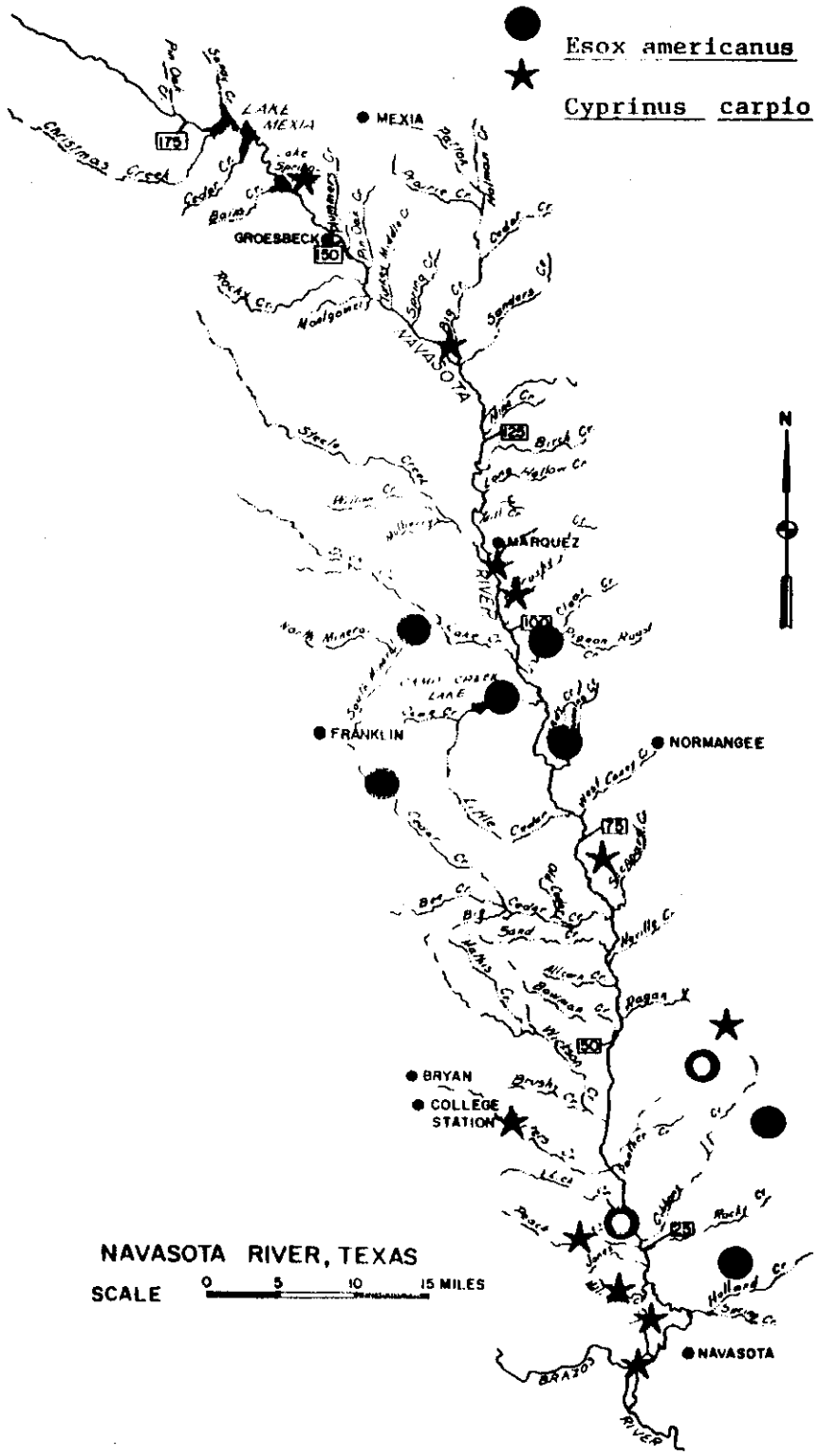
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MARQUEZ
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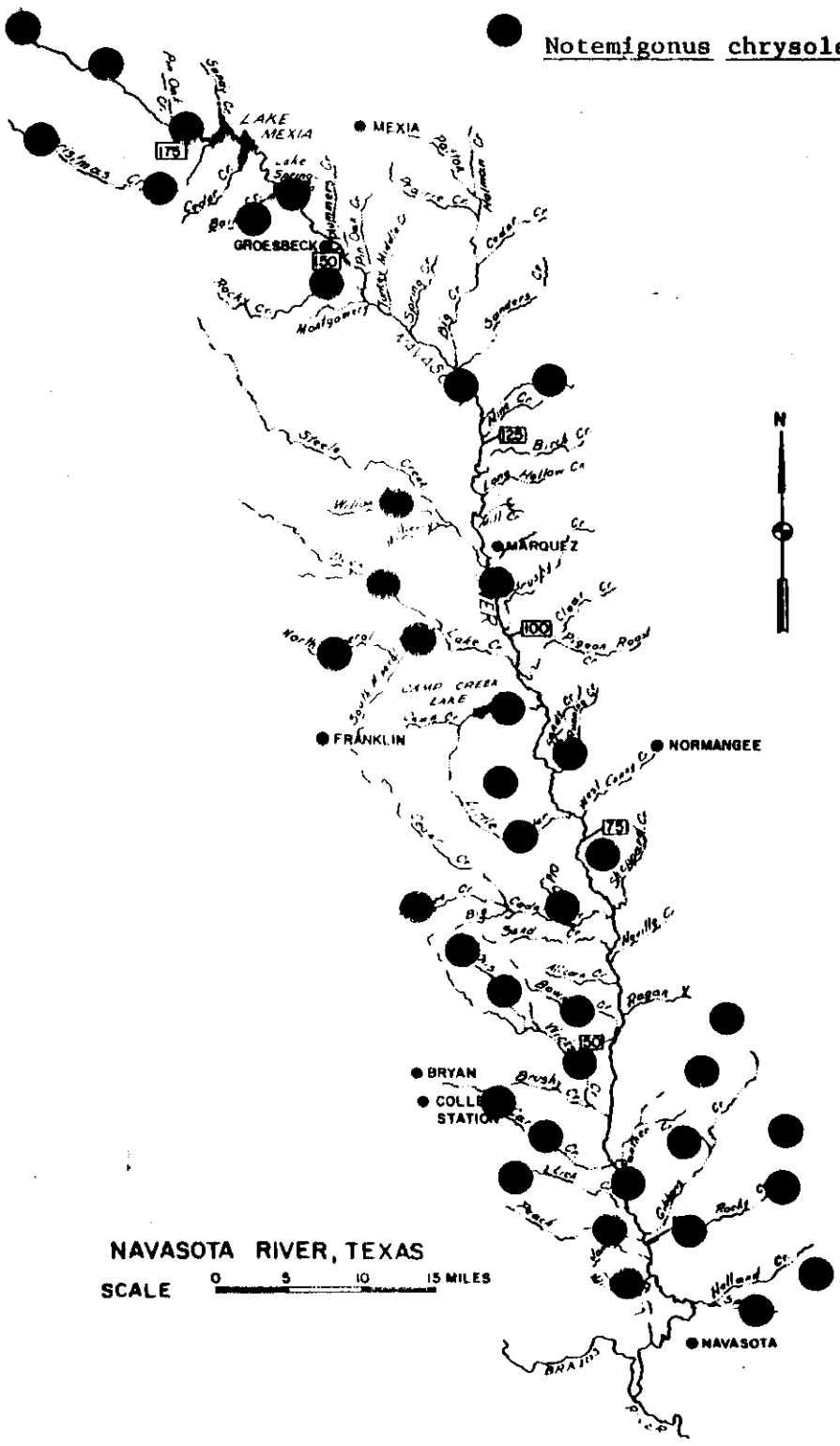
N
NAVASOTA RIVER, TEXAS
SCALE 0 5 10 15 MILES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FRANKLIN
NORMANGEE
BRYAN
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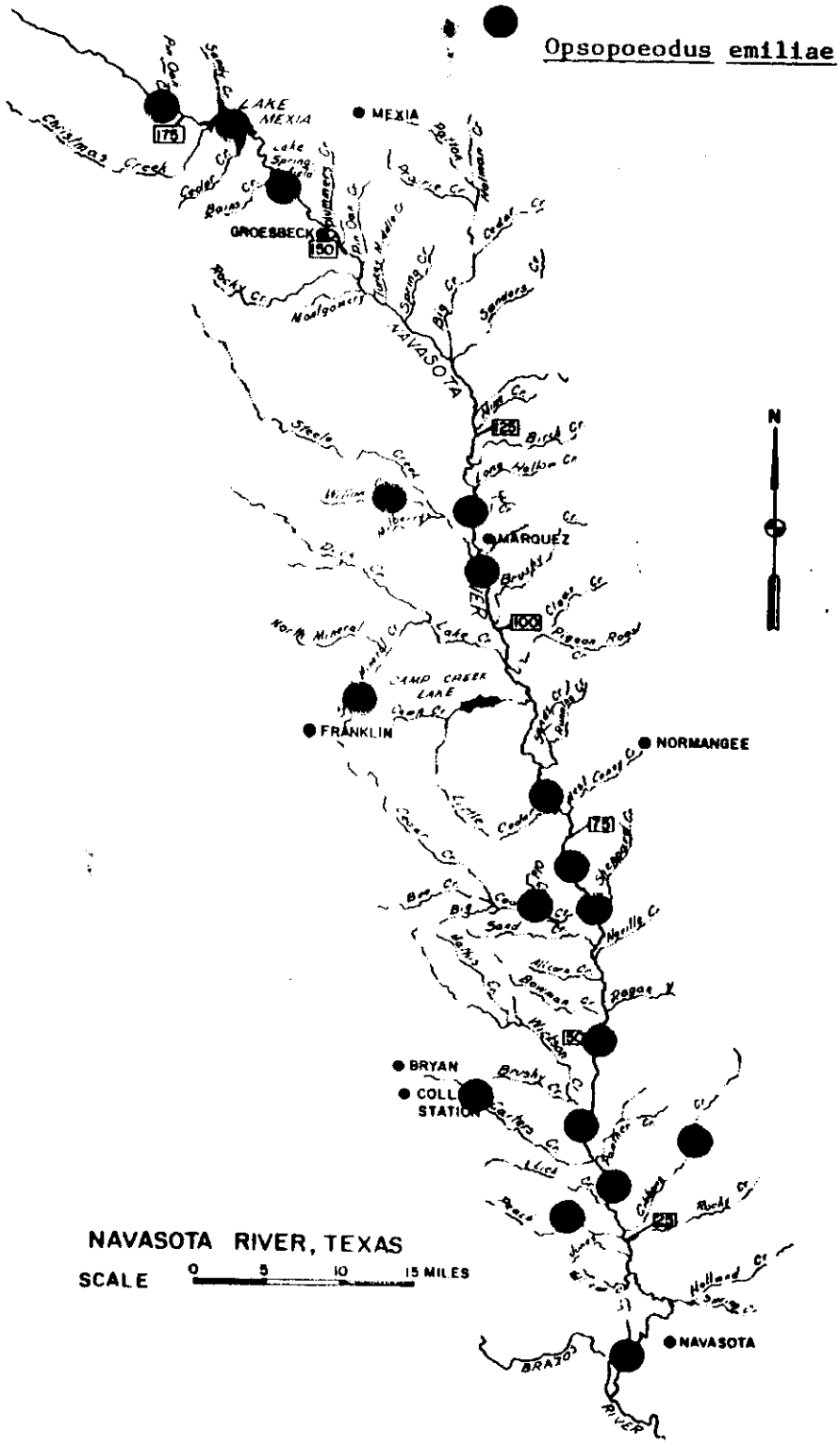
NAVASOTA RIVER, TEXAS
SCALE 0 5 10 15 MILES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GROESBECK
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MARQUEZ
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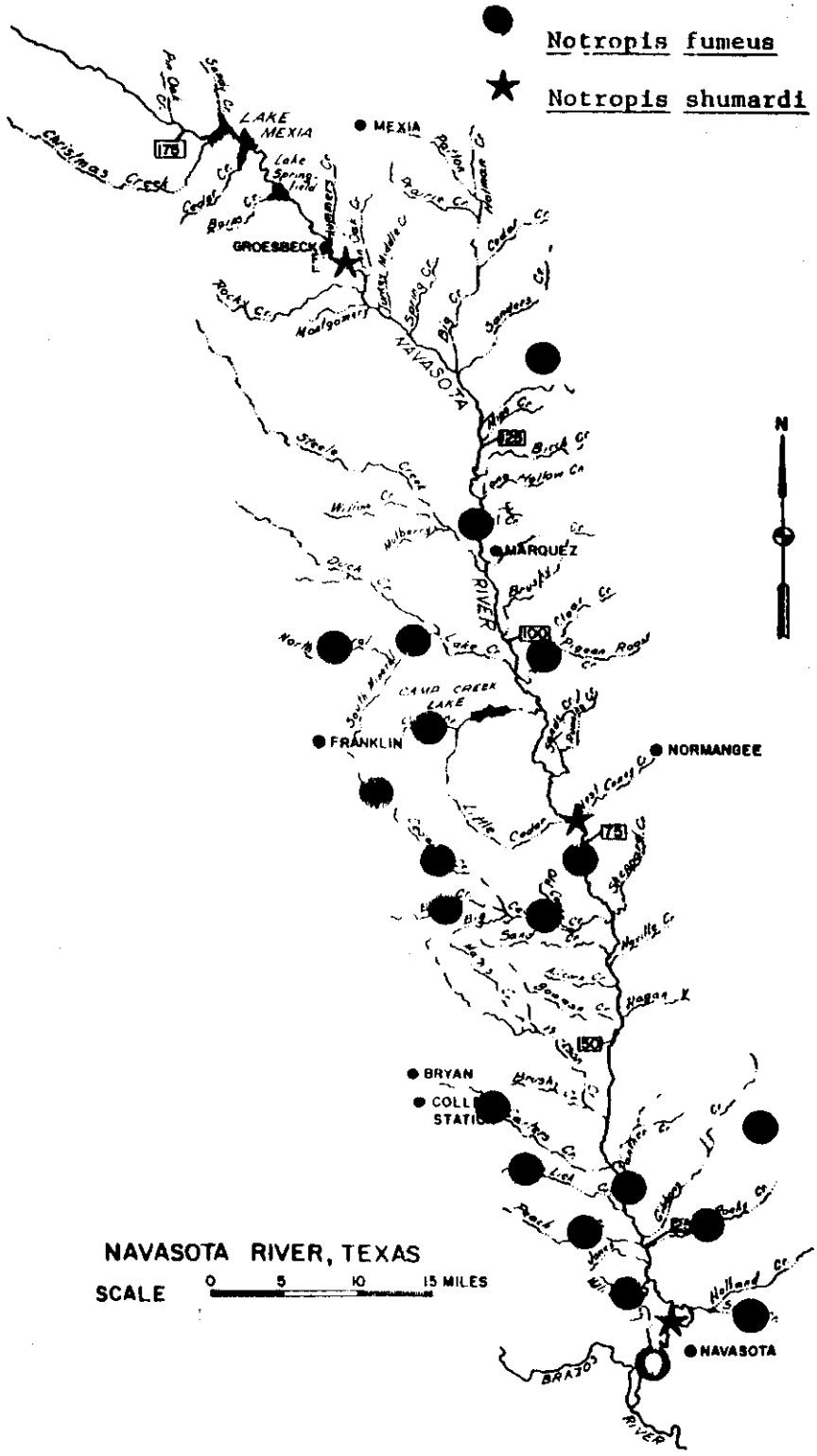
BRYAN
COLL STATION
NAVASOTA
BRAZOS RIVER
N
NAVASOTA RIVER, TEXAS
SCALE 0 5 10 15 MILES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Notropis shumardi
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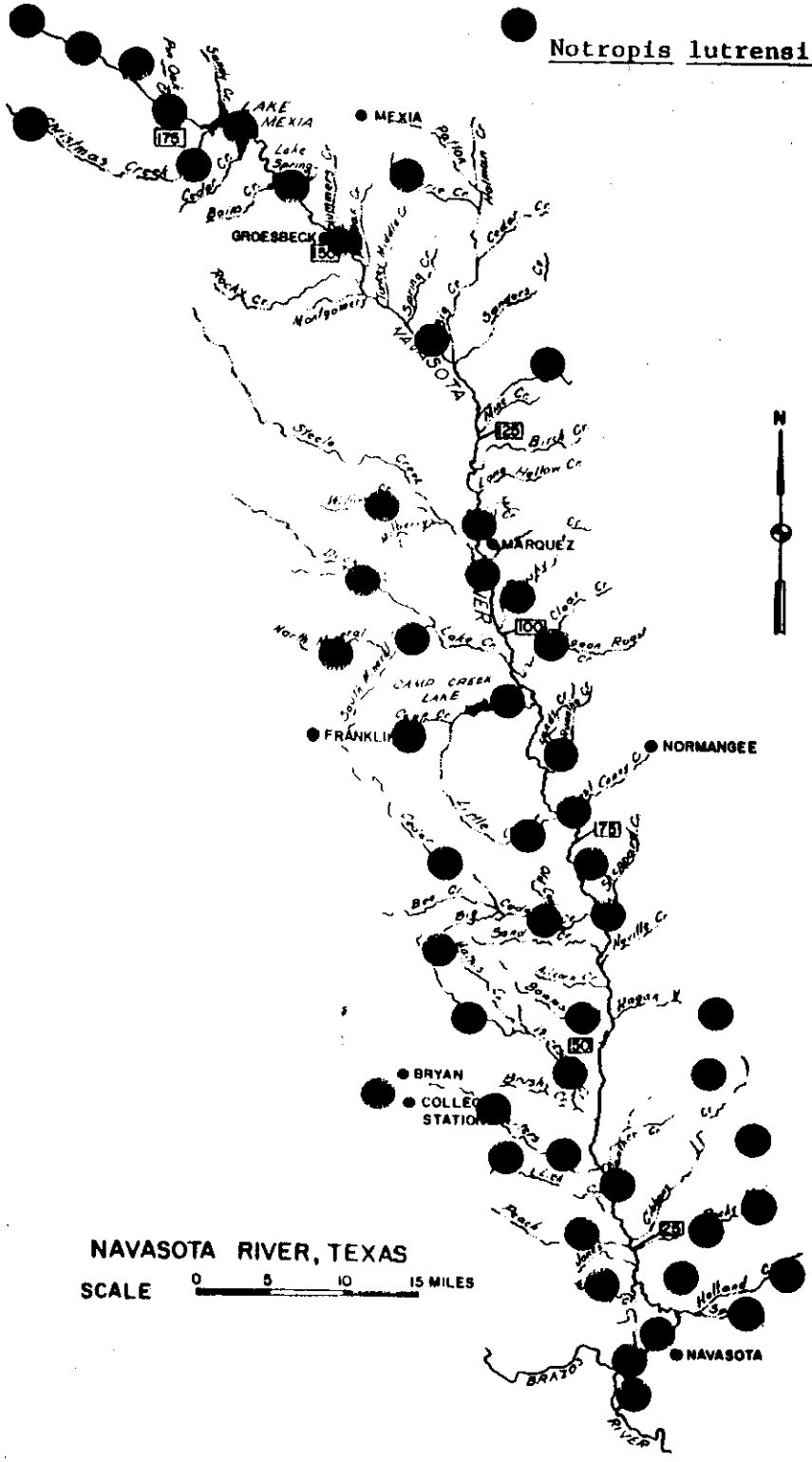
MEXIA
GROESBECK
NAVASOTA
MARQUEZ
RIVER
FRANKLIN
NORMANGEE
BRYAN
NAVASOTA
BRAZOS
RIVER
N
NAVASOTA RIVER, TEXAS
SCALE
0 5 10 15 MILES


Notropis lutrensis
LAKE MEXIA
MEXIA
GROESBECK
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FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
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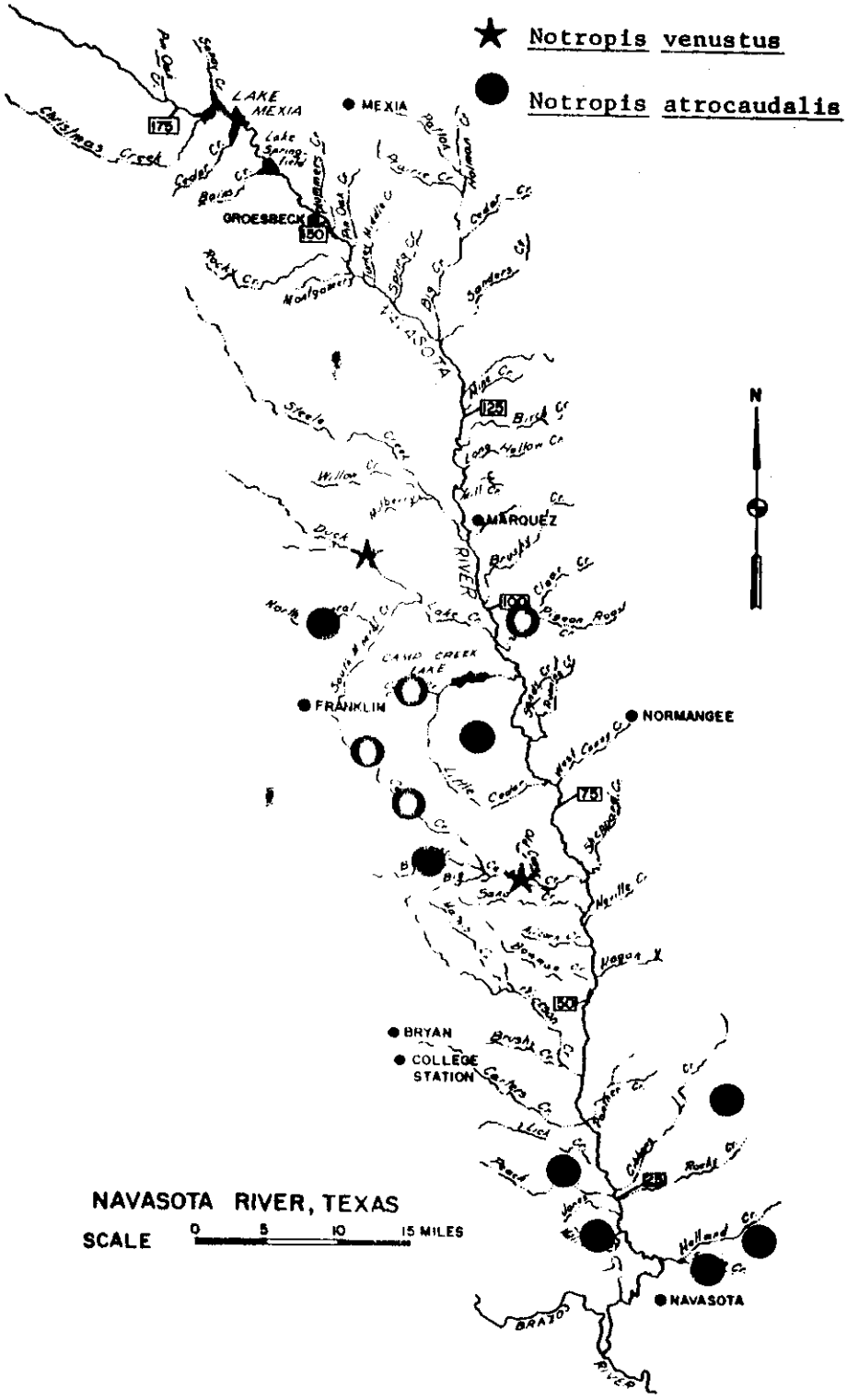
SCALE 0 5 10 15 MILES


Notropis venustus
Notropis atrocaudalis
LAKE MEXIA
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
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COLLEGE STATION
NAVASOTA
NAVASOTA RIVER
BRAZOS RIVER
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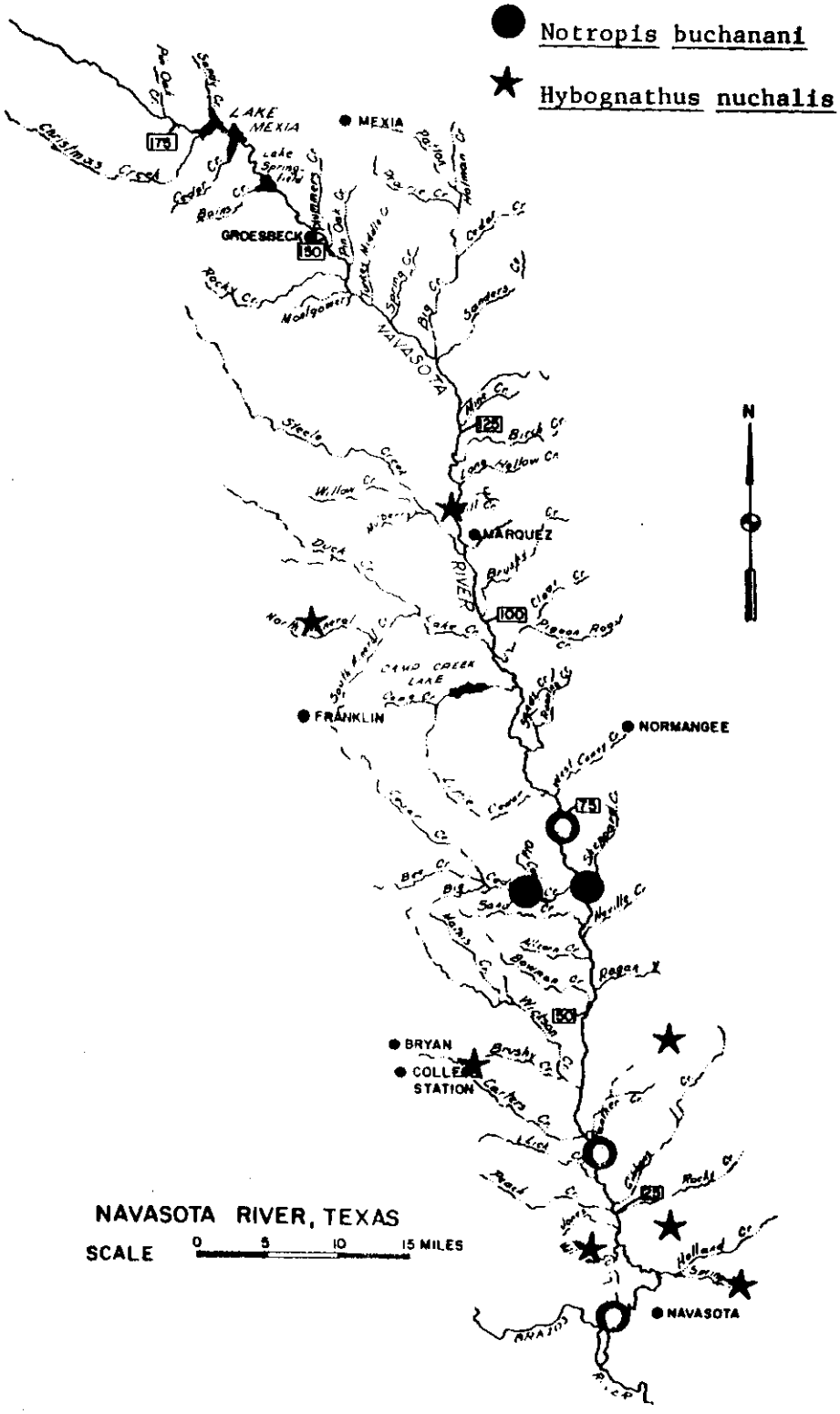
Notropis buchanani
Hybognathus nuchalis
LAKE MEXIA
MEXIA
GROESBECK
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BRYAN
COLLEGE STATION
NAVASOTA
NAVASOTA RIVER, TEXAS
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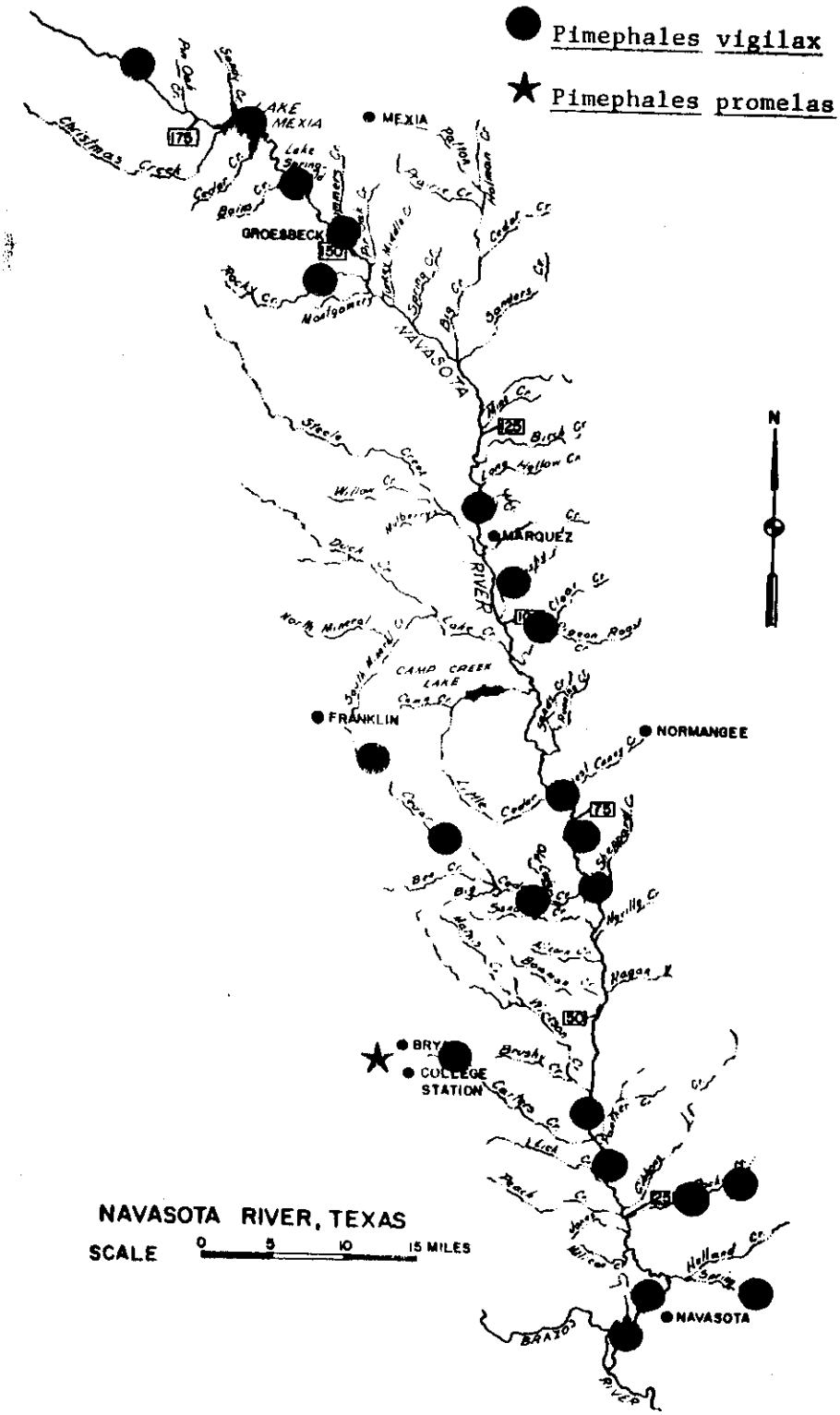
Pimephales vigilax
Pimephales promelas
LAKE MEXIA
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
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CAMP CREEK LAKE
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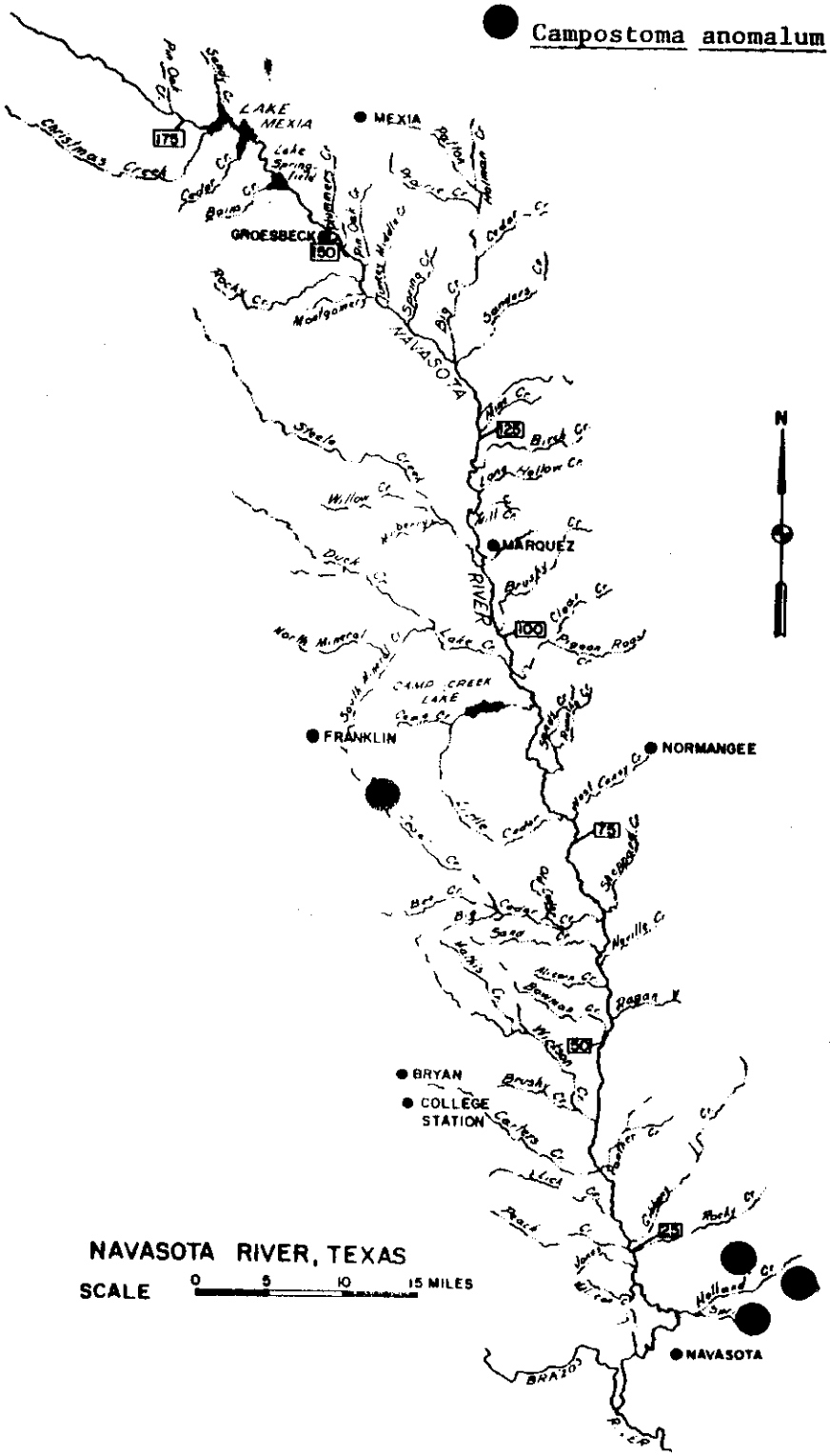
Campostoma anomalum
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MEXIA
GROESBECK
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
NAVASOTA RIVER
CAMP CREEK LAKE
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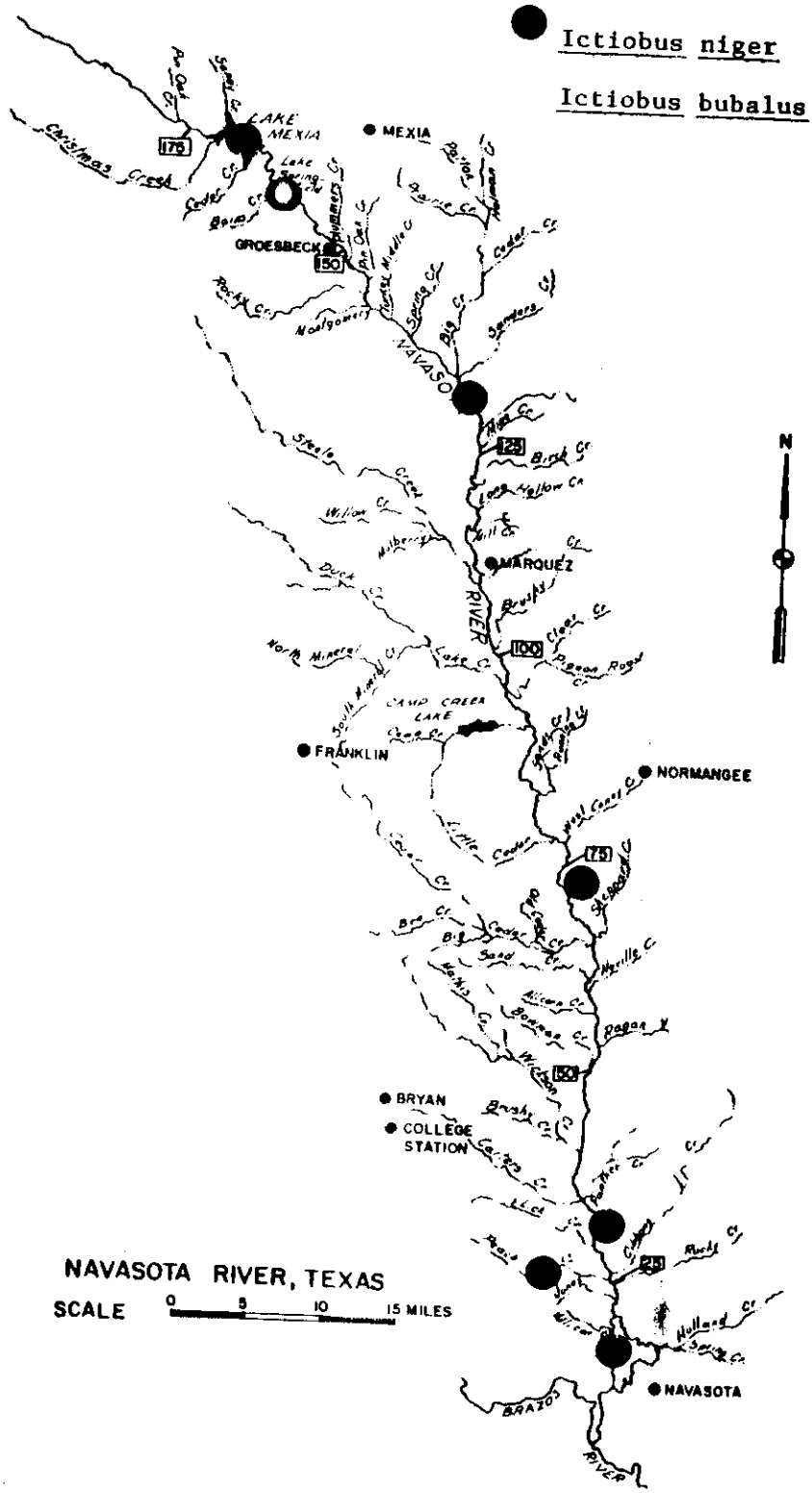
Ictiobus niger
Ictiobus bubalus
LAKE MEXIA
MEXIA
GROESBECK
NAVASO
MARQUEZ
RIVER
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BRYAN
COLLEGE STATION
NAVASOTA
BRAZOS RIVER
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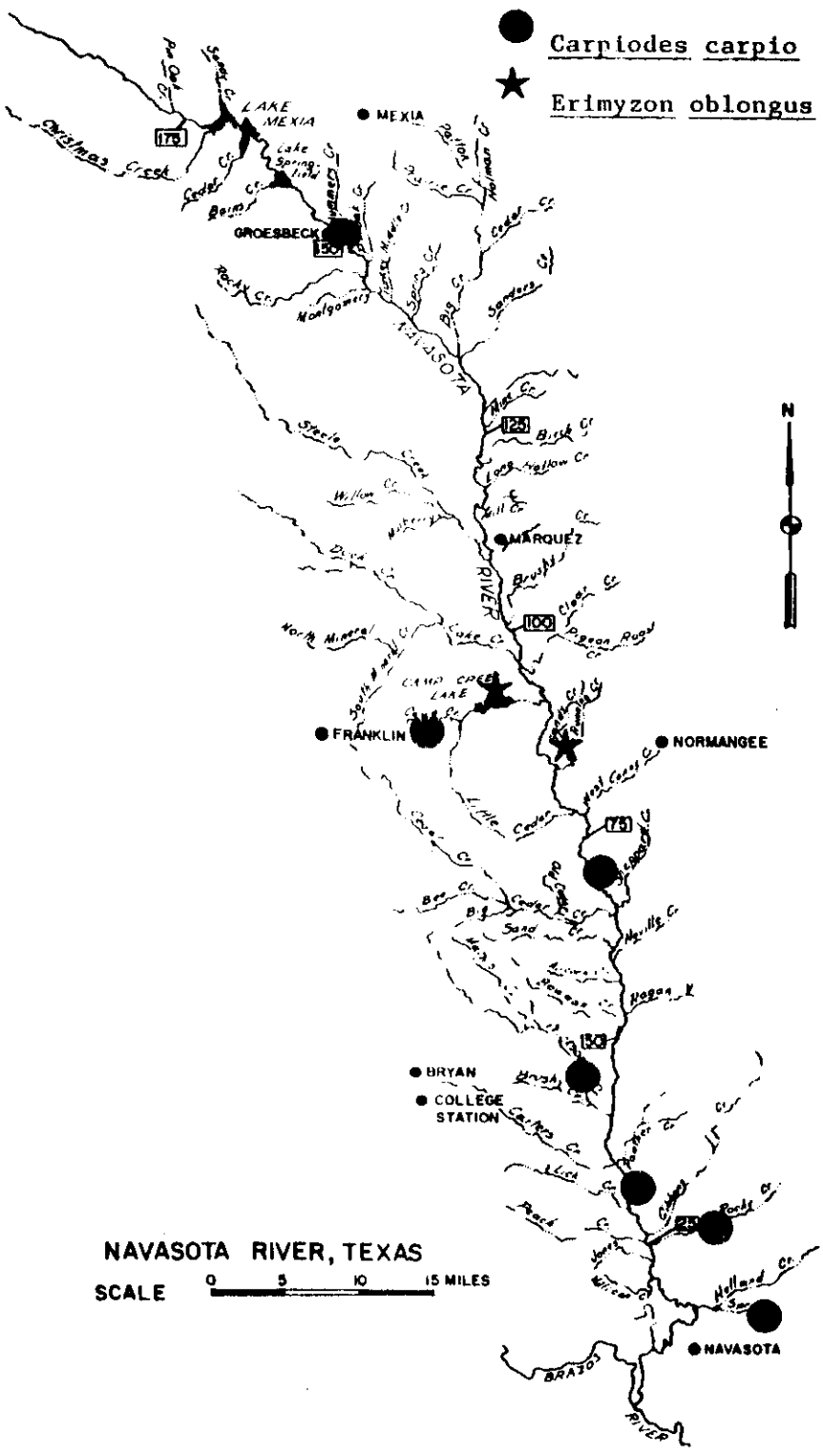
SCALE 0 5 10 15 MILES


Carpiodes carpio
Erimyzon oblongus
LAKE MEXIA
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
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NAVASOTA RIVER
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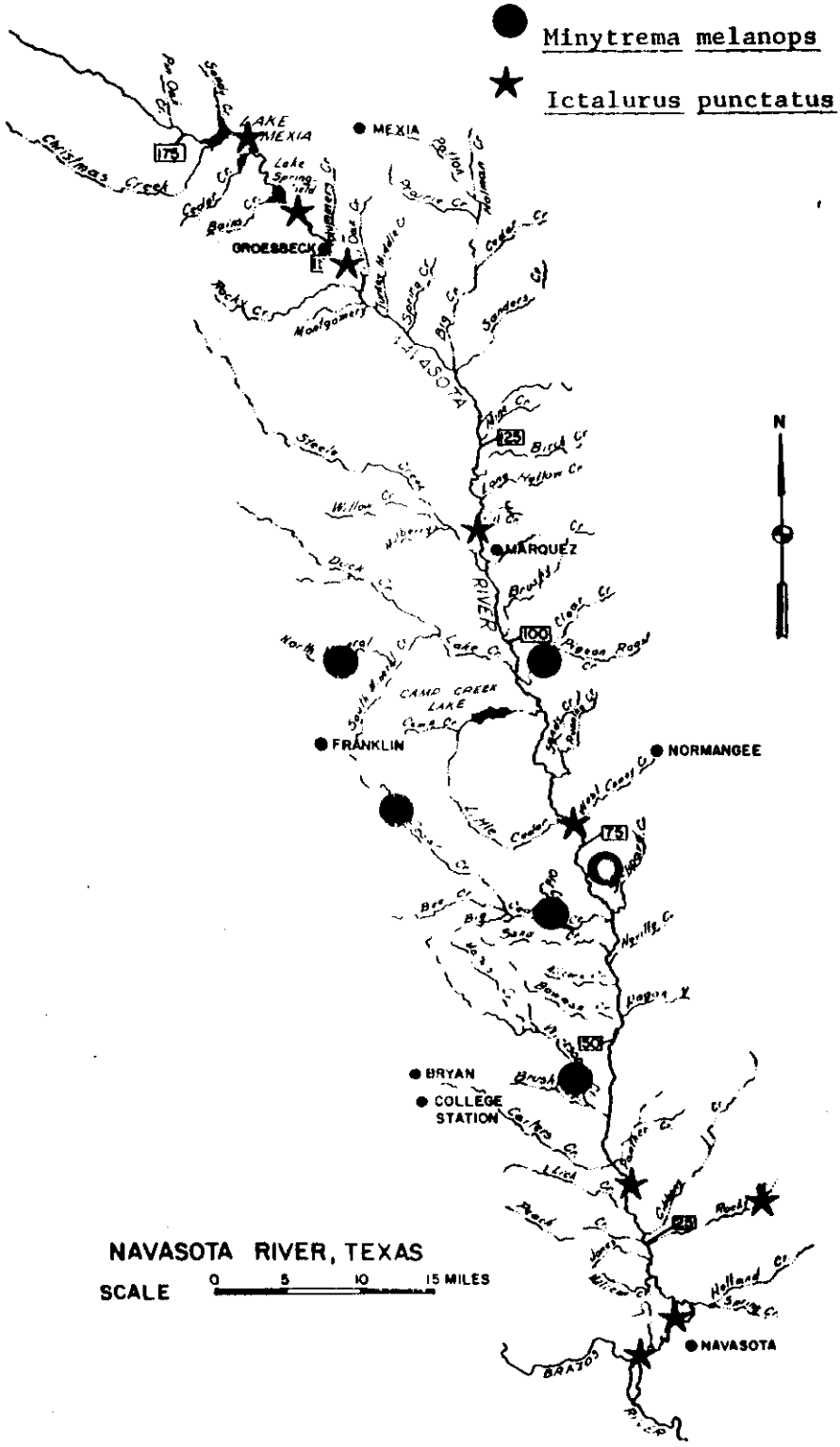
Minytrema melanops
Ictalurus punctatus
LAKE MEXIA
MEXIA
GROESBECK
MARQUEZ
NAVASOTA RIVER
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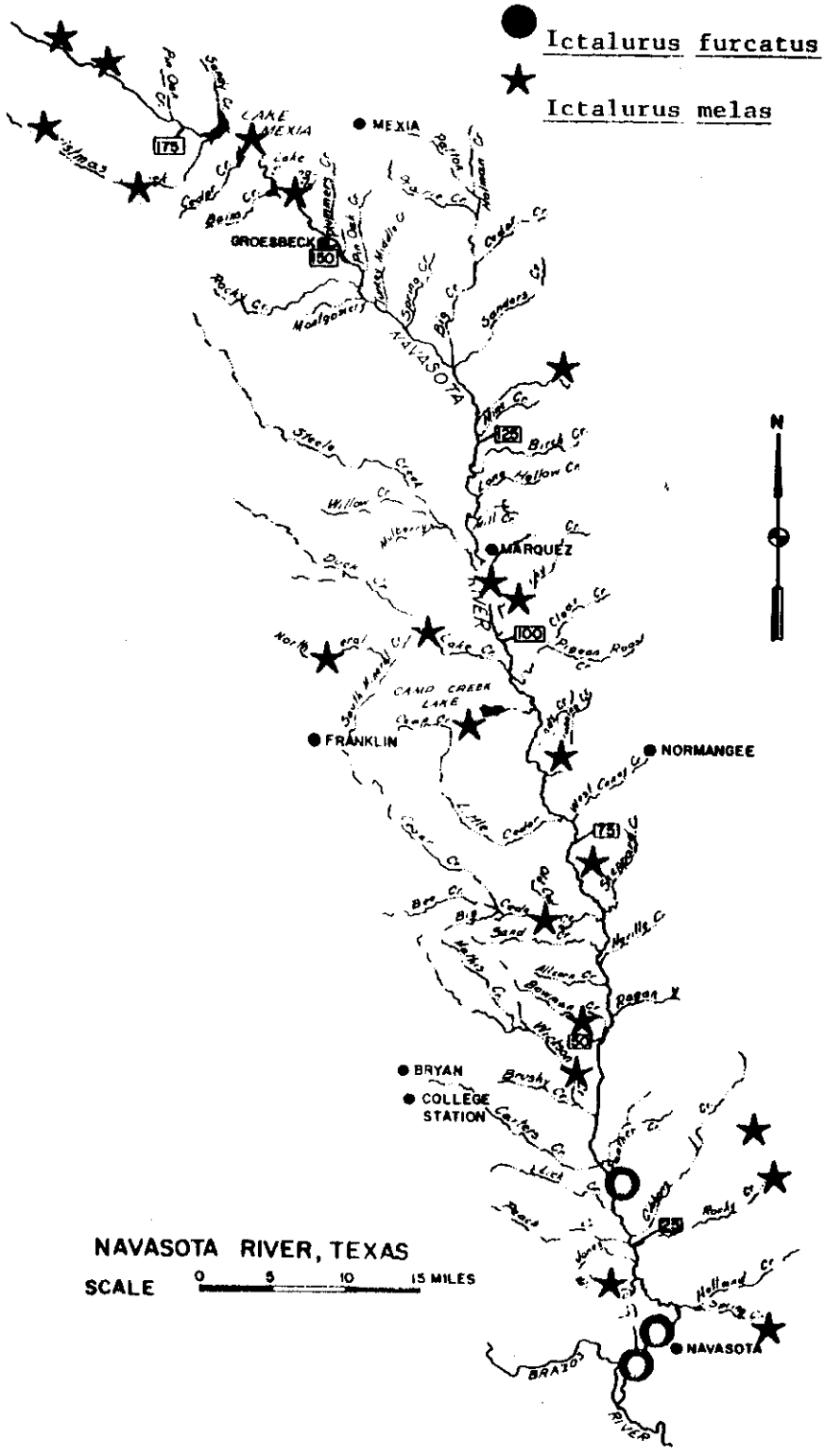
Ictalurus furcatus
Ictalurus melas
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
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BRYAN
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LAKE MEXIA
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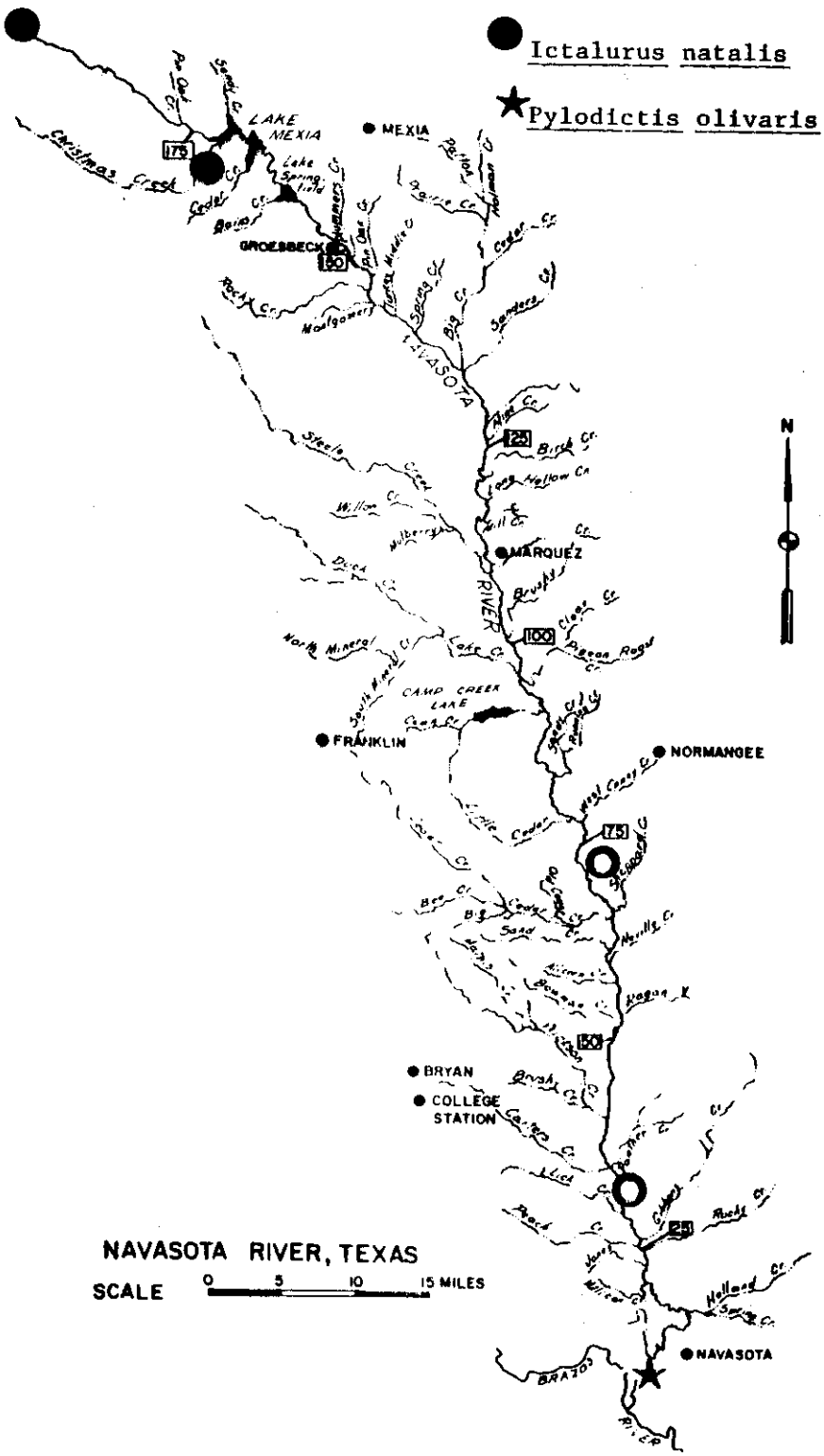
SCALE 0 5 10 15 MILES


Ictalurus natalis
Pylodictis olivaris
LAKE MEXIA
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
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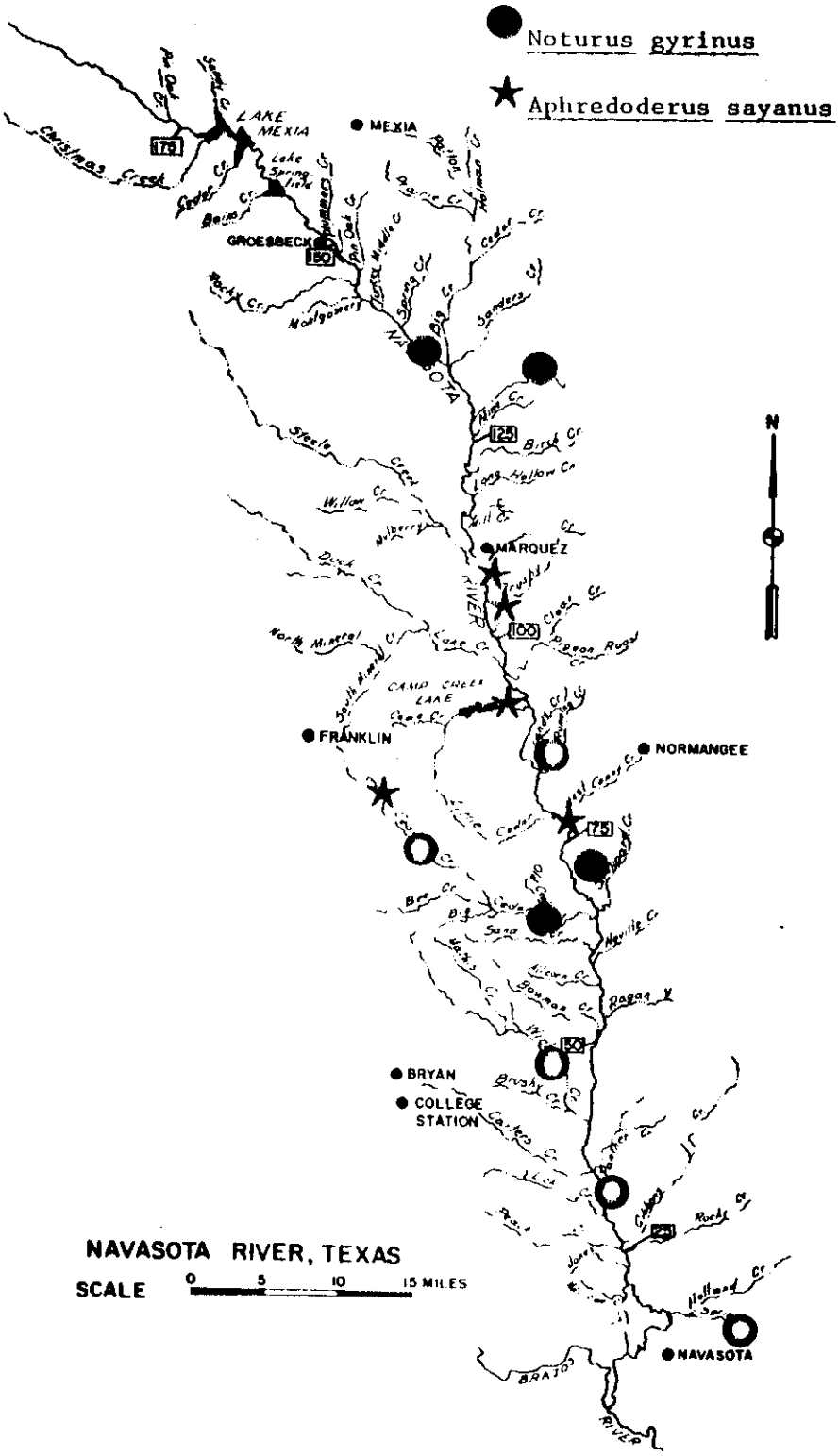
Noturus gyrinus
Aphredoderus sayanus
LAKE MEXIA
MEXIA
GROESBECK
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COLLEGE STATION
NAVASOTA
RIVER
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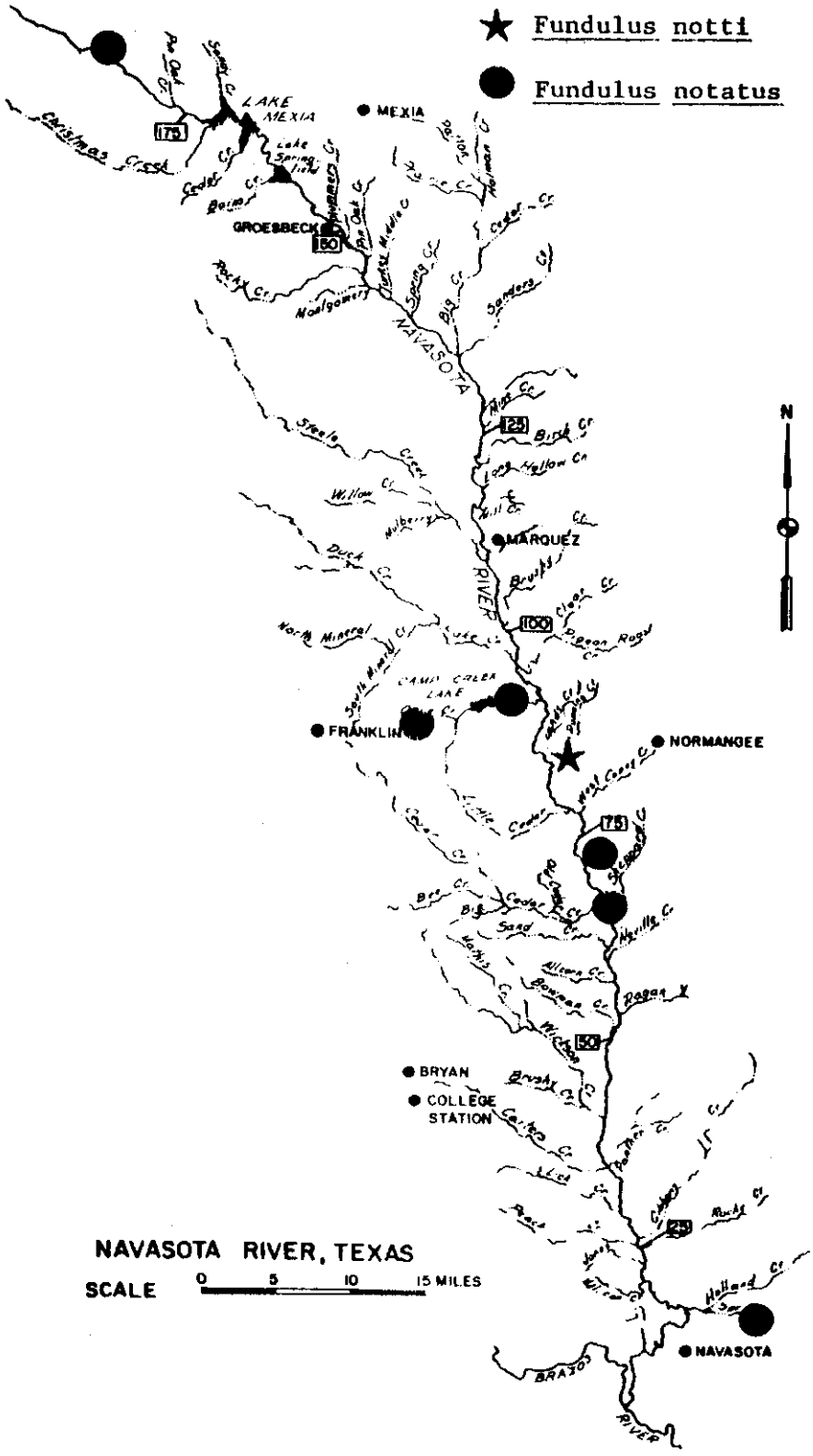
SCALE 0 5 10 15 MILES


Fundulus notti
Fundulus notatus
LAKE MEXIA
MEXIA
GROESBECK
NAVASOTA RIVER
MARQUEZ
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BRYAN
COLLEGE STATION
NAVASOTA
BRAZOS RIVER
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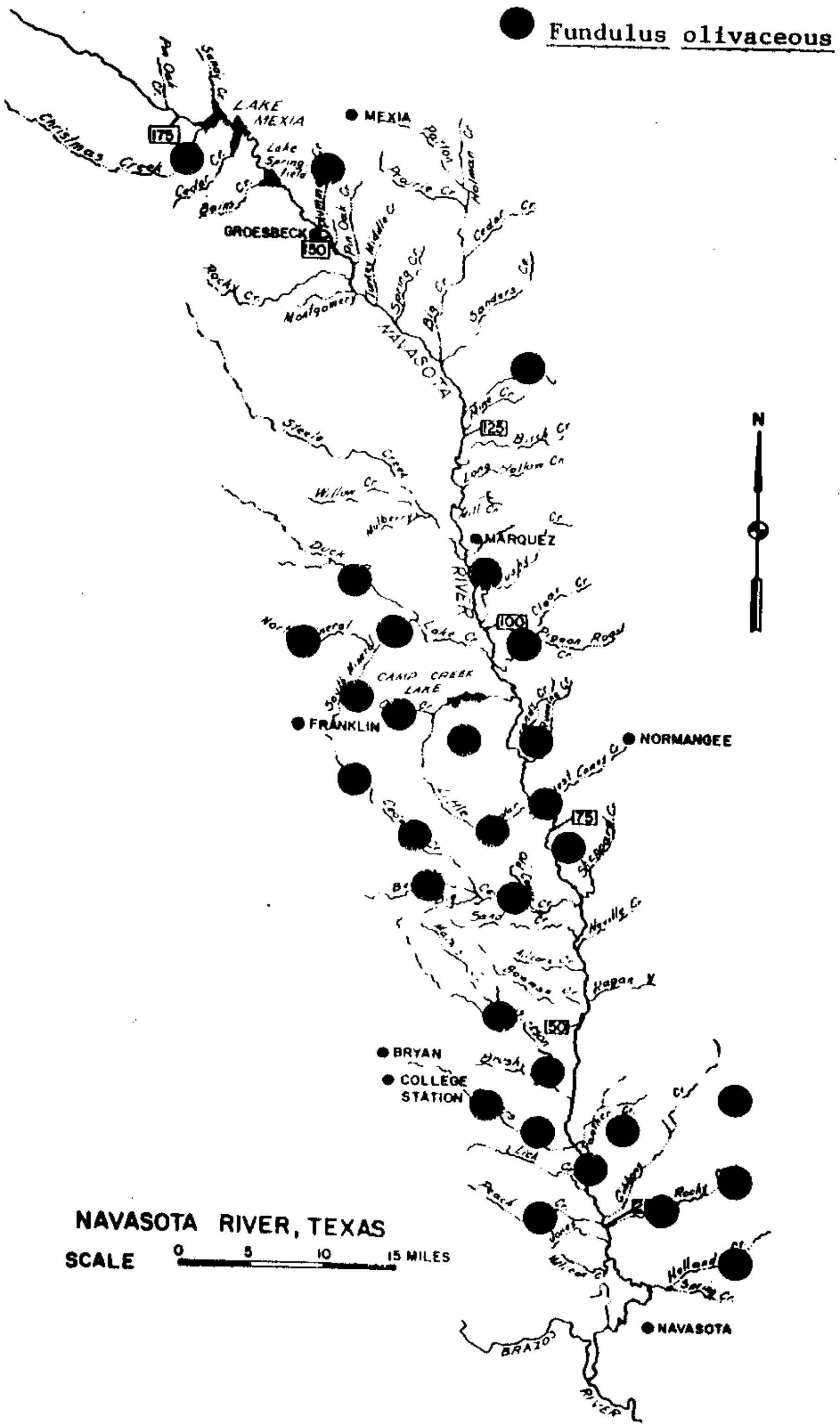
SCALE 0 5 10 15 MILES


Fundulus olivaceous
LAKE MEXIA
MEXIA
GROESBECK
MARQUEZ
NAVASOTA RIVER
FRANKLIN
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BRYAN
COLLEGE STATION
NAVASOTA
BRAZOS RIVER
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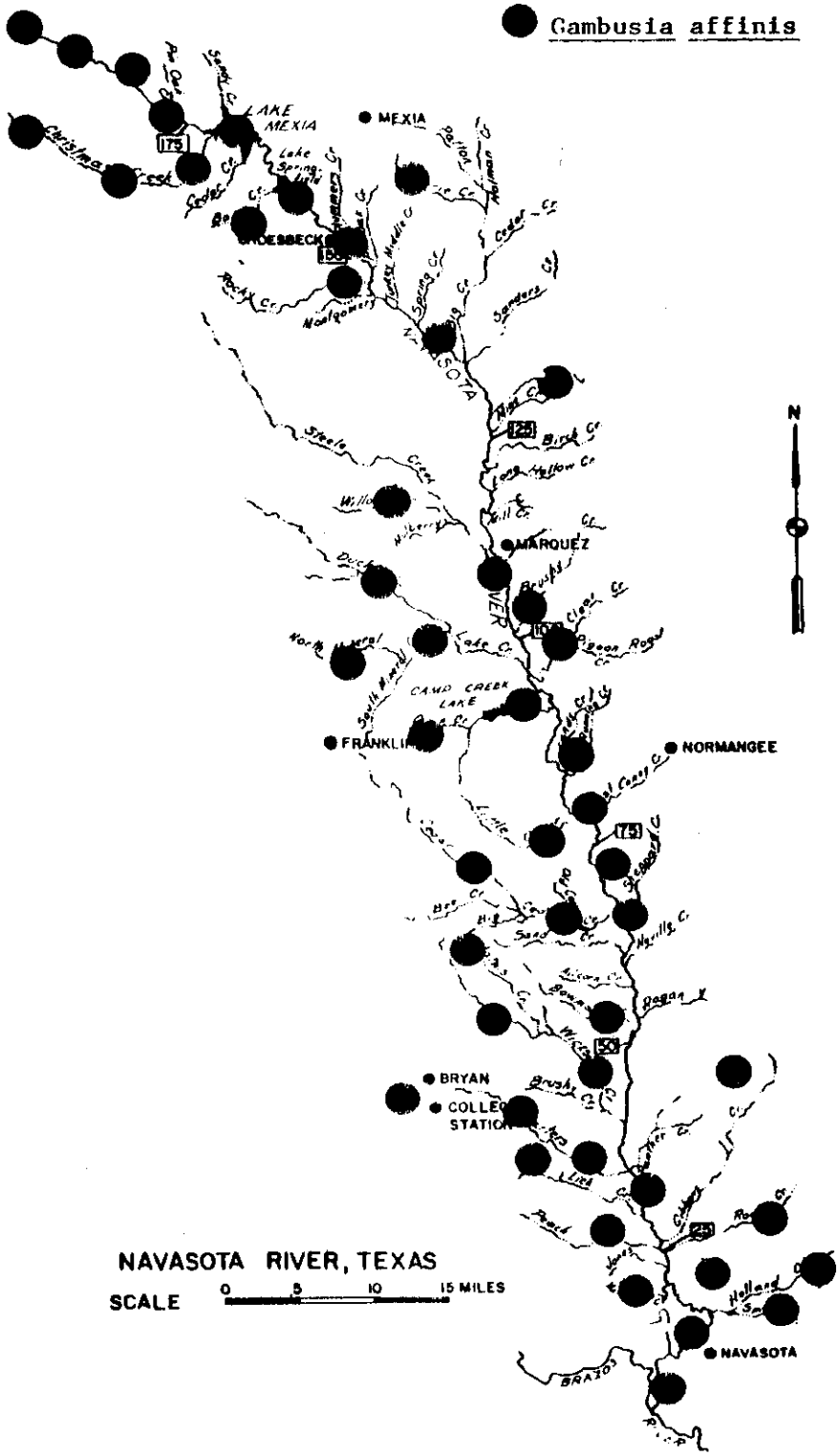
SCALE 0 5 10 15 MILES


Gambusia affinis
LAKE MEXIA
MEXIA
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
CAMP CREEK LAKE
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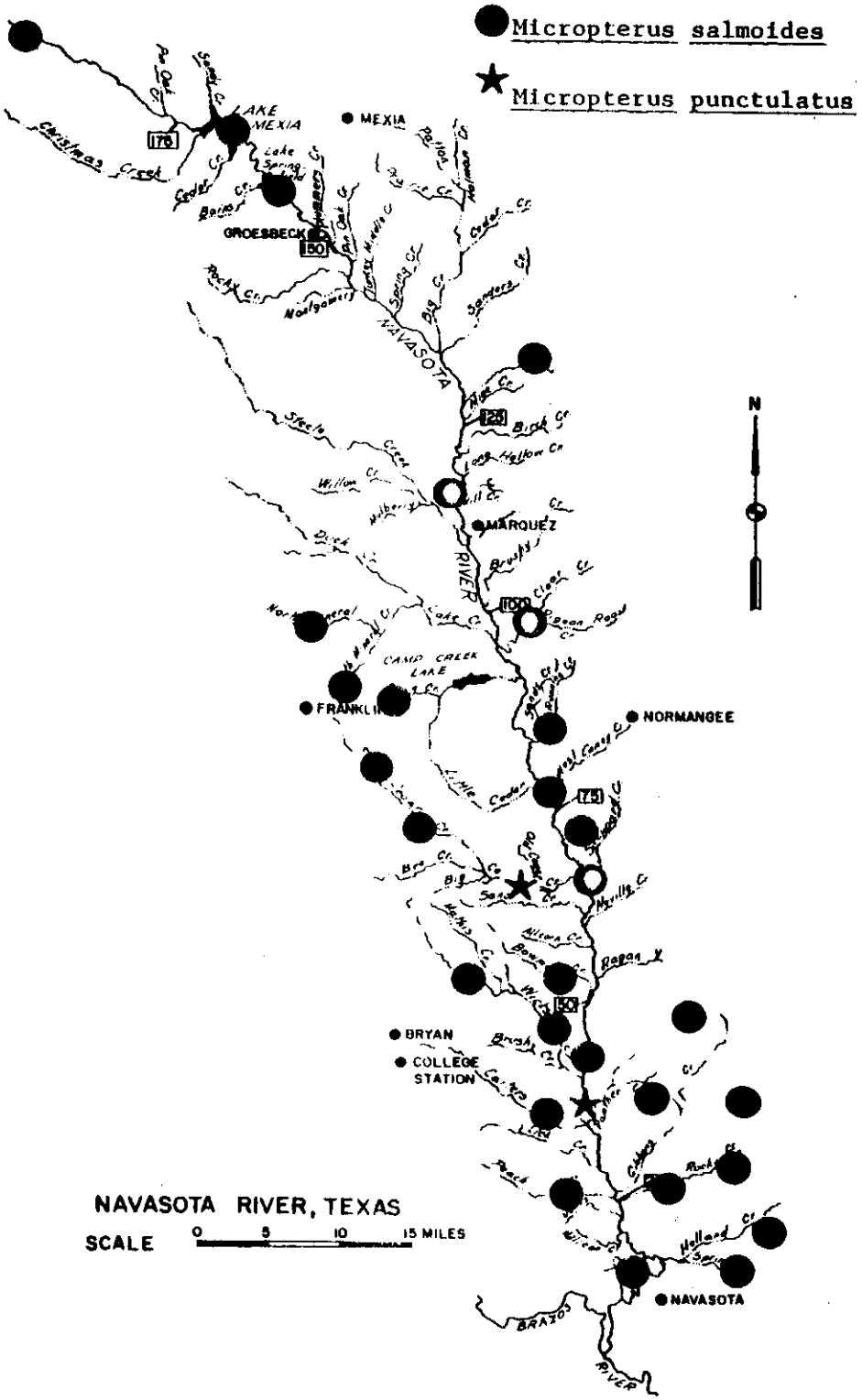
NAVASOTA RIVER, TEXAS
SCALE
0 5 10 15 MILES


Micropterus salmoides
Micropterus punctulatus
LAKE MEXIA
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
NAVASOTA RIVER
BRAZOS RIVER
CASID CREEK LAKE
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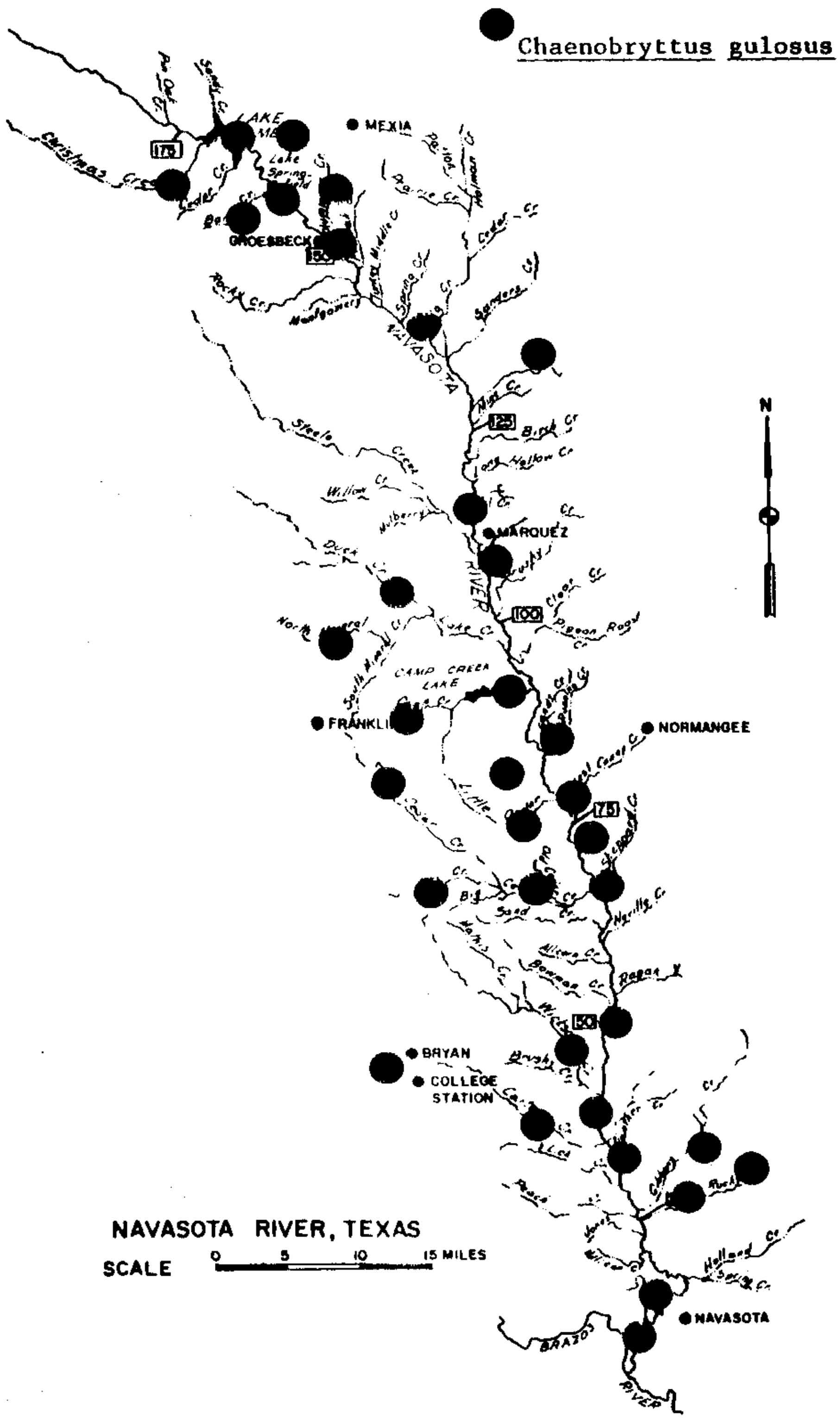
SCALE 0 5 10 15 MILES


Chaenobryttus gulosus
NAVASOTA RIVER, TEXAS
SCALE
0
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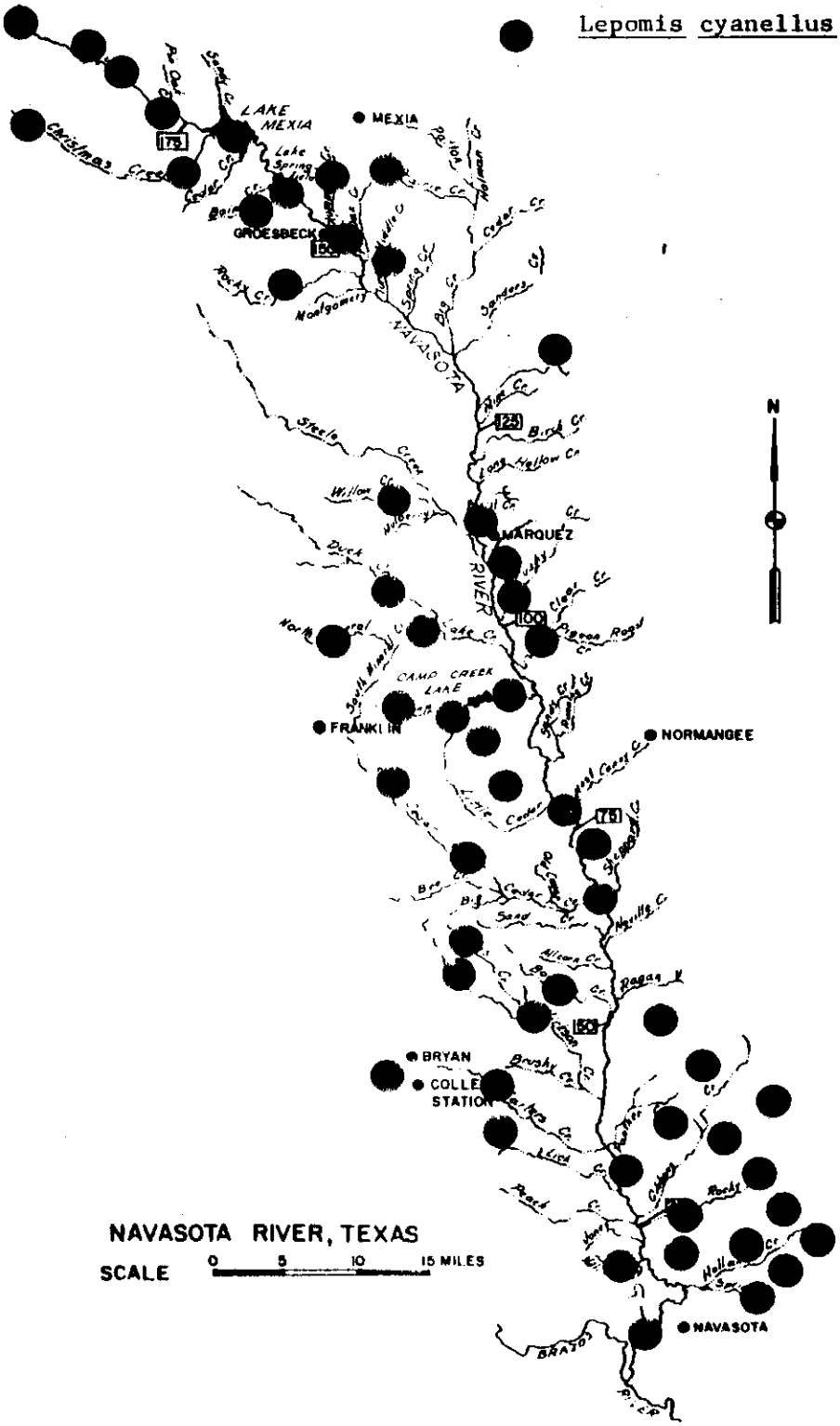
10
15 MILES
N
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
NAVASOTA RIVER
CAMP CREEK LAKE
BRAZOS RIVER


Lepomis cyanellus
LAKE MEXIA
MEXIA
GROESBECK
NAVASOTA RIVER
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
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CAMP CREEK LAKE
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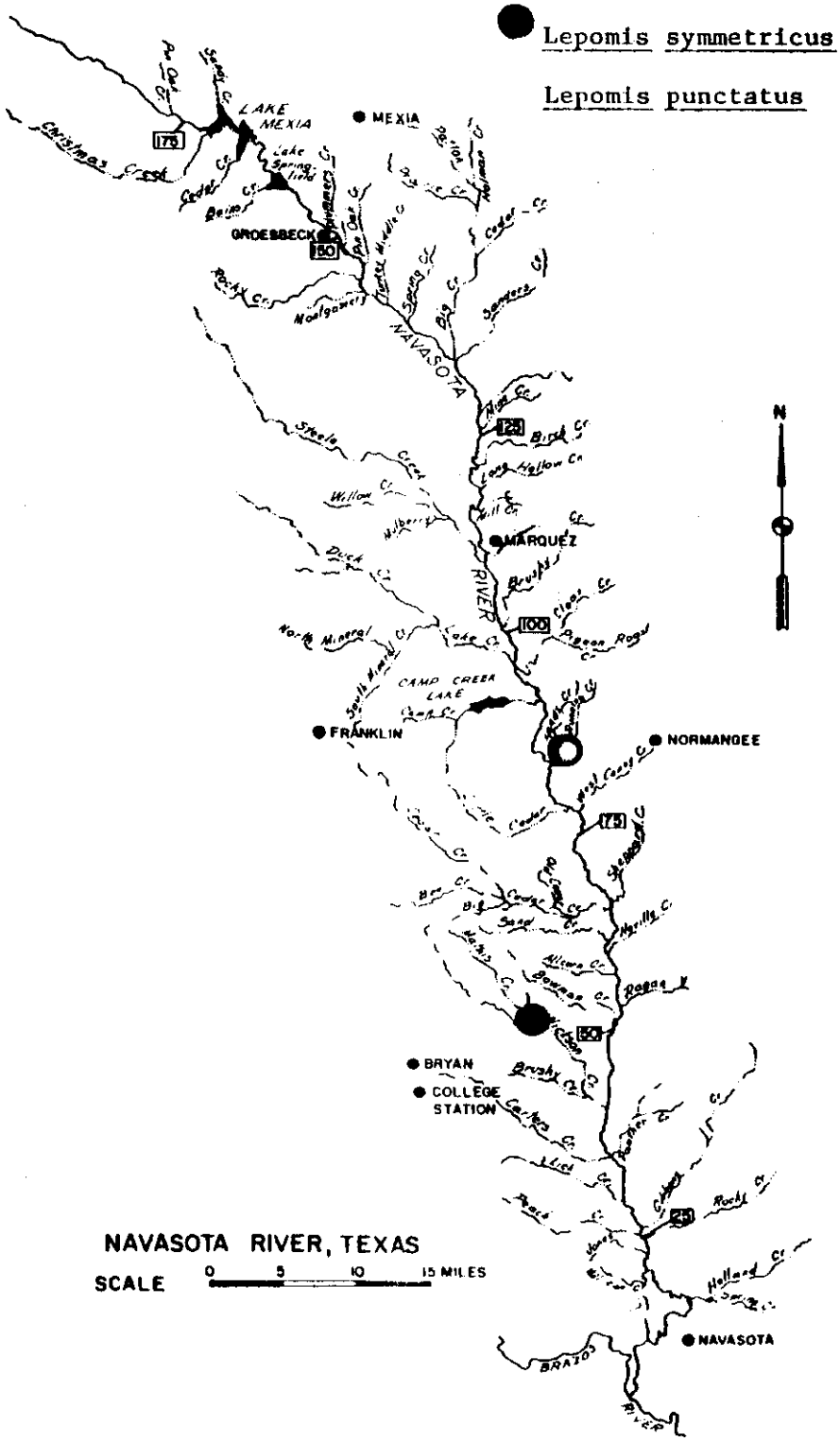
SCALE 0 5 10 15 MILES


Lepomis symmetricus
Lepomis punctatus
LAKE MEXIA
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
CAMP CREEK LAKE
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COLLEGE STATION
NAVASOTA
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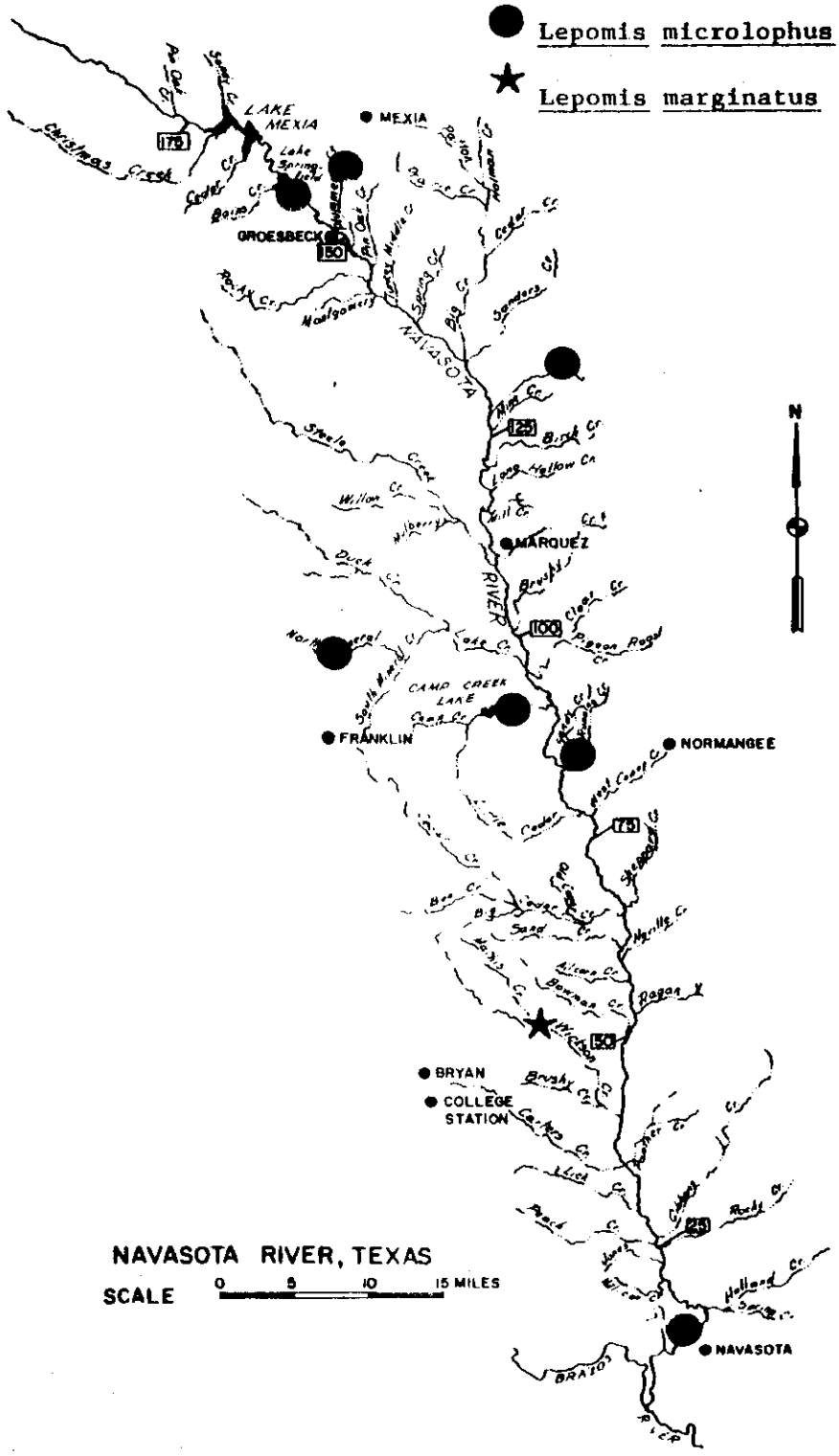
Lepomis microlophus
Lepomis marginatus
LAKE MEXIA
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
CAMP CREEK LAKE
NORMANGEE
BRYAN
COLLEGE STATION
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NAVASOTA RIVER
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SCALE
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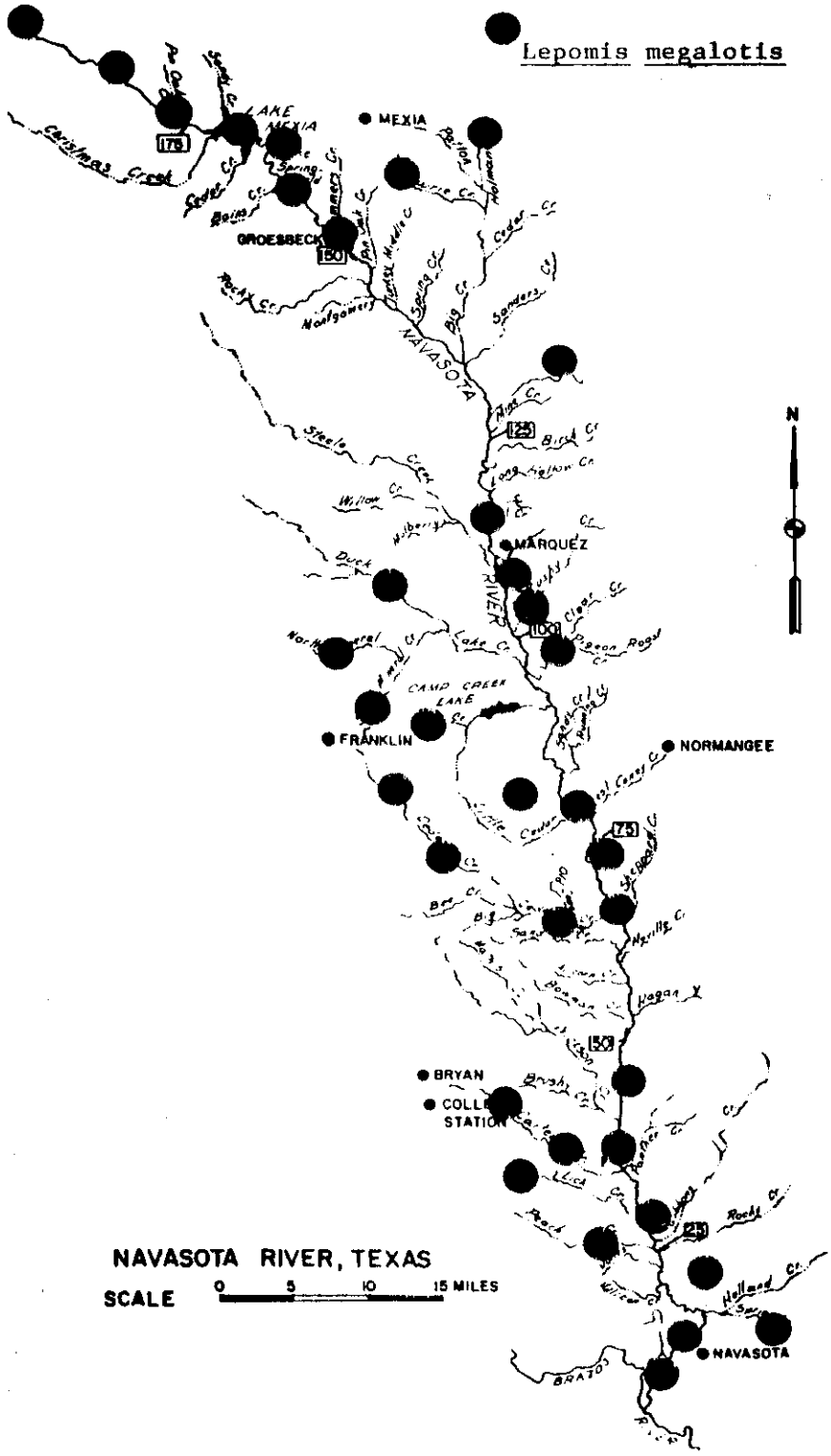
Lepomis megalotis
LAKE MEXIA
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
CAMP CREEK LAKE
NORMANGEE
BRYAN
NAVASOTA
NAVASOTA RIVER, TEXAS
SCALE 0 5 10 15 MILES
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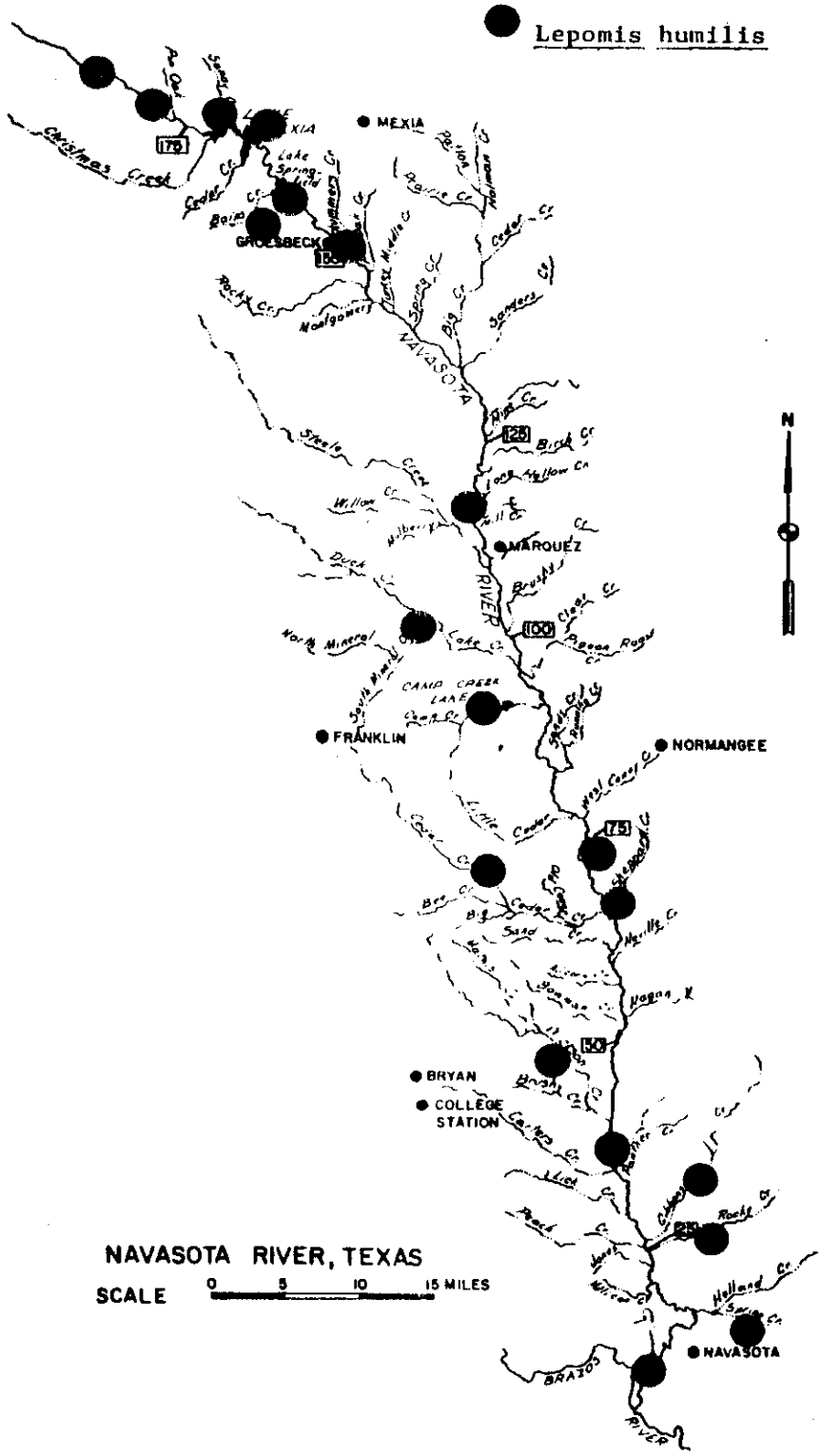
Lepomis humilis
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
NAVASOTA RIVER
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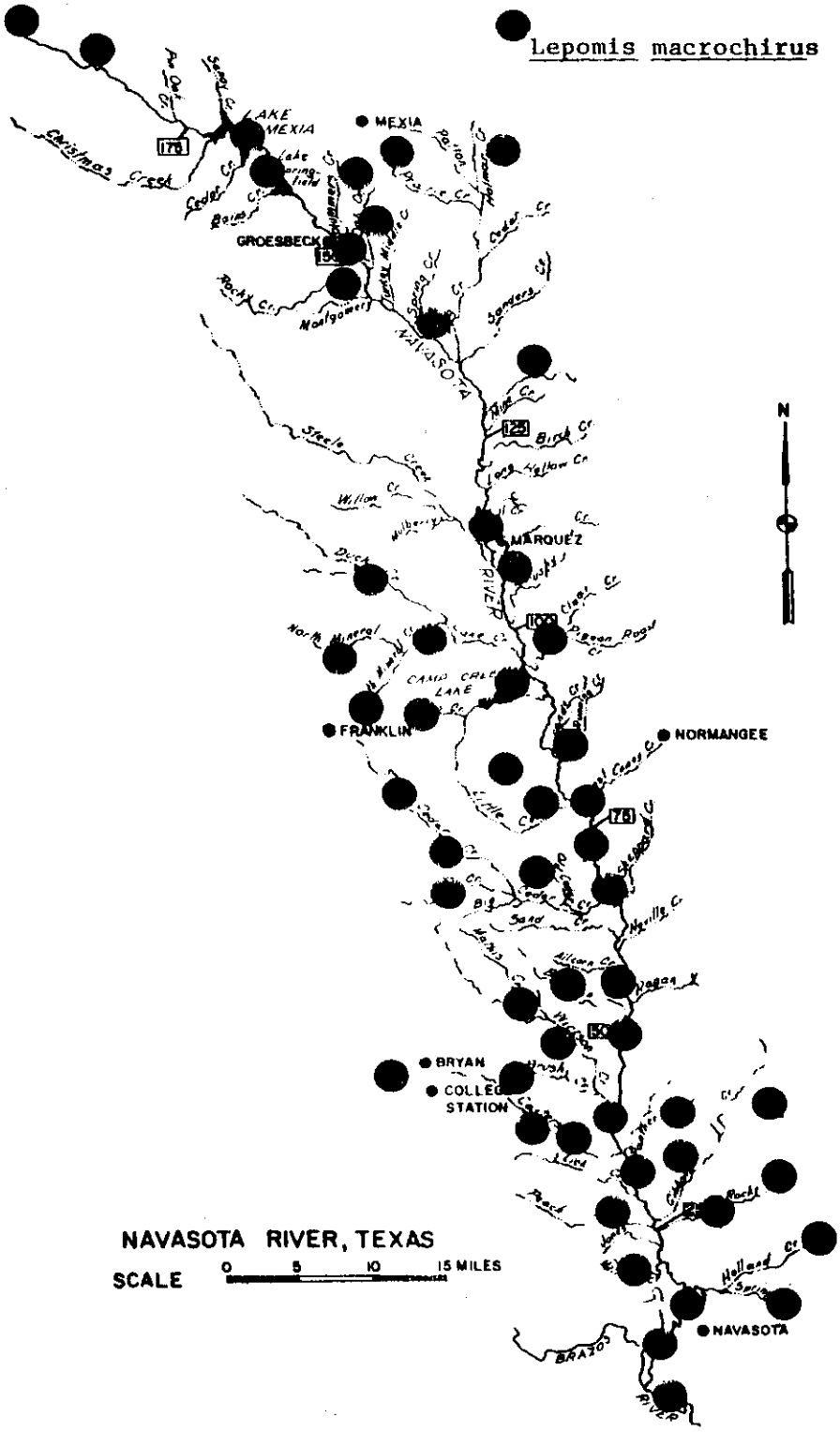
Lepomis macrochirus
LAKE MEXIA
MEXIA
GROESBECK
NAVASOTA
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COLLEGE STATION
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BRAZOS
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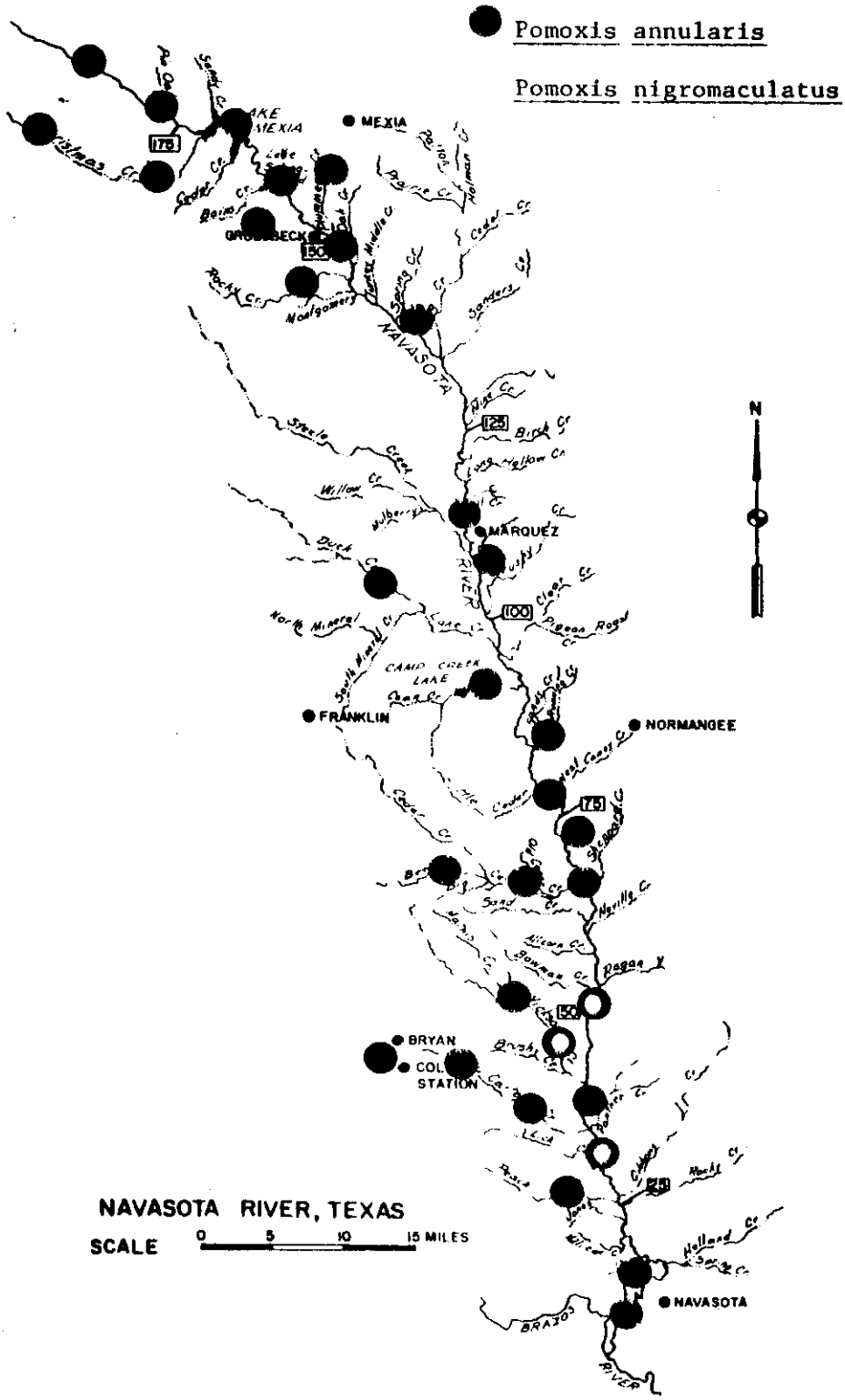
SCALE 0 5 10 15 MILES


Pomoxis annularis
Pomoxis nigromaculatus
MEXIA
GROESBECK
NAVASOTA
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
BRAZOS RIVER
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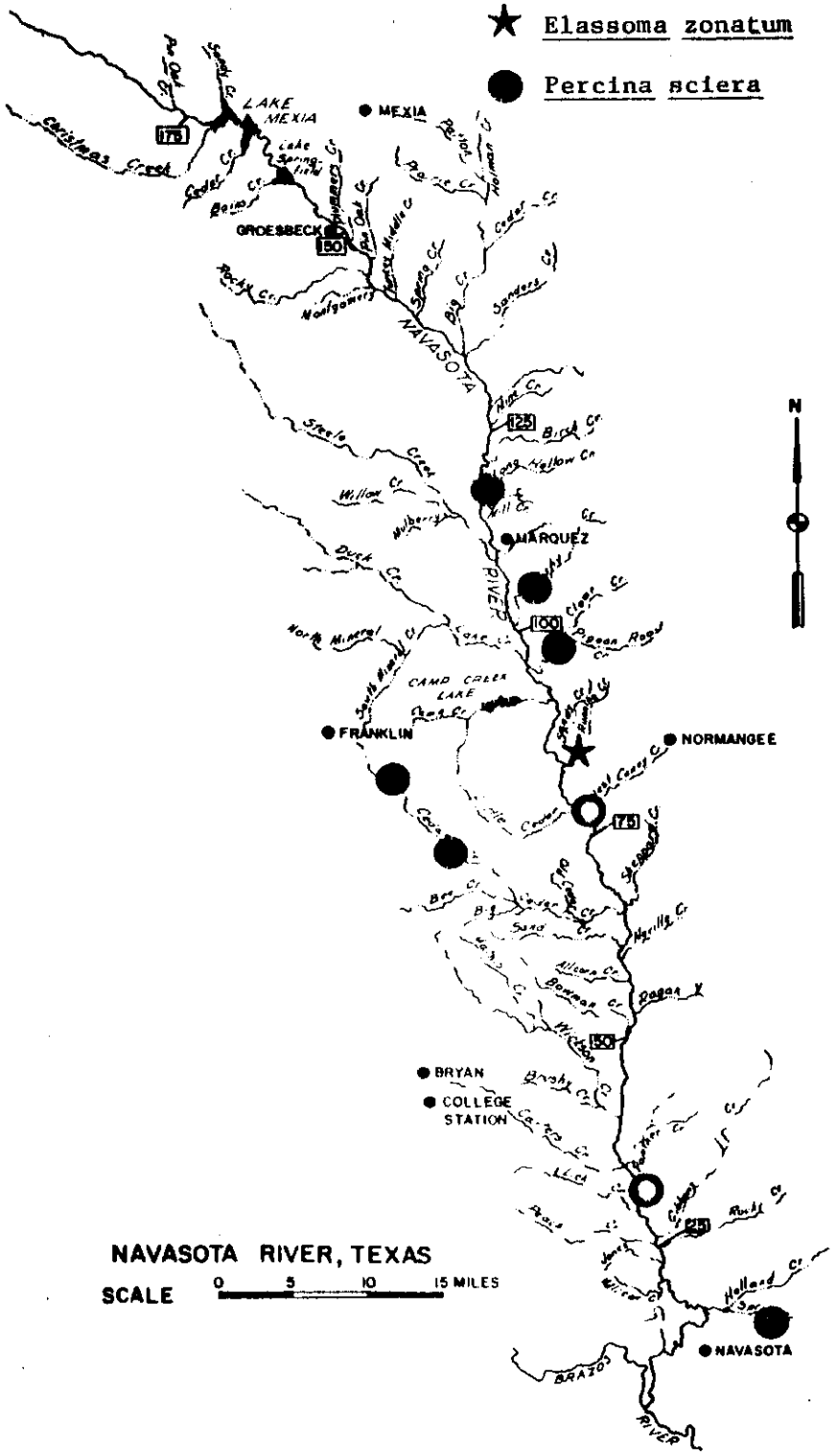
NAVASOTA RIVER, TEXAS
SCALE 0 5 10 15 MILES


Elassoma zonatum
Percina sciera
LAKE MEXIA
MEXIA
GROESBECK
NAVASOTA RIVER
MARQUEZ
FRANKLIN
NORMANGEE
CAMP CREEK LAKE
BRYAN
COLLEGE STATION
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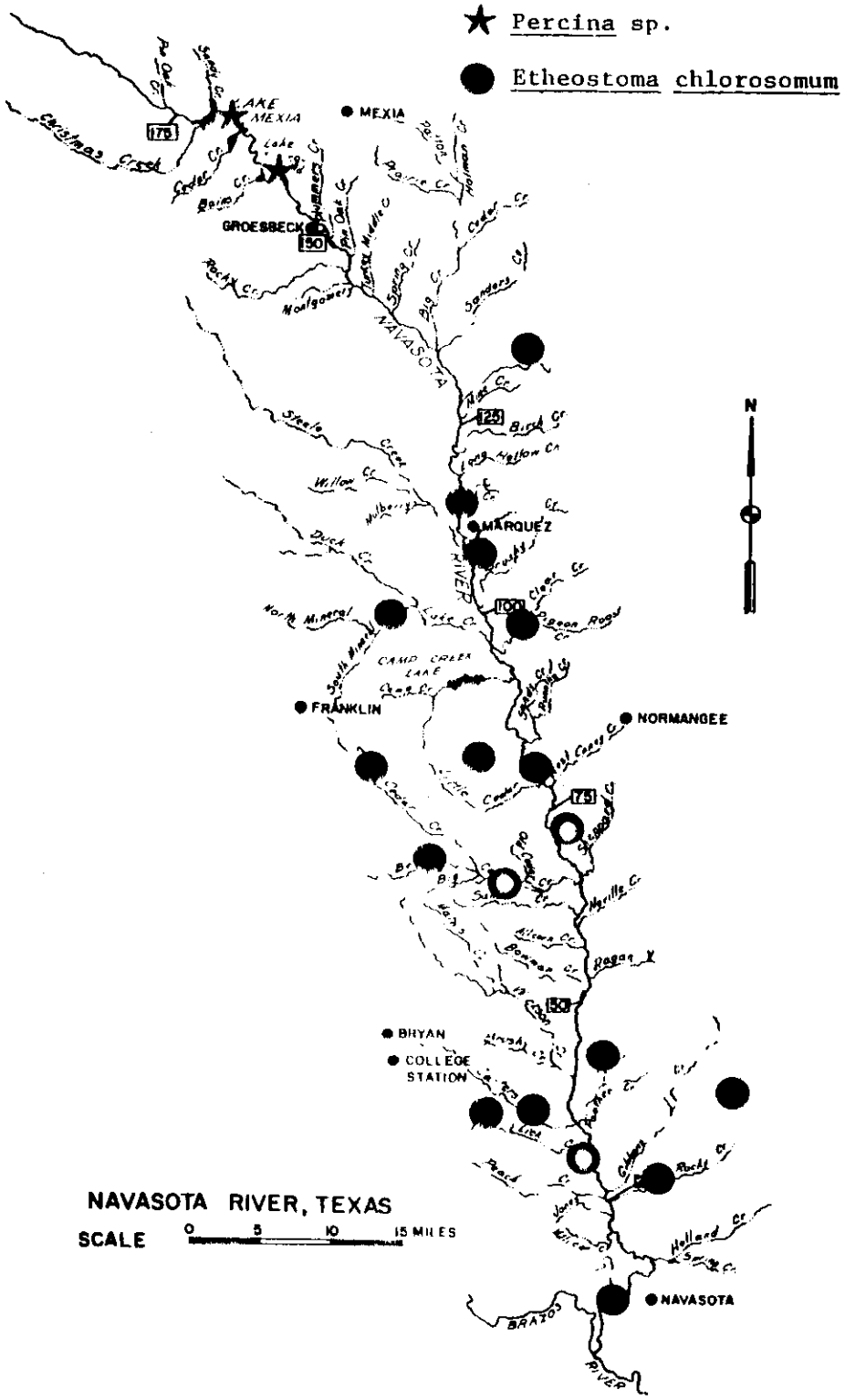
★ Percina sp.
● Etheostoma chlorosomum
LAKE MEXIA
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
NAVASOTA RIVER
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CAMP CREEK LAKE
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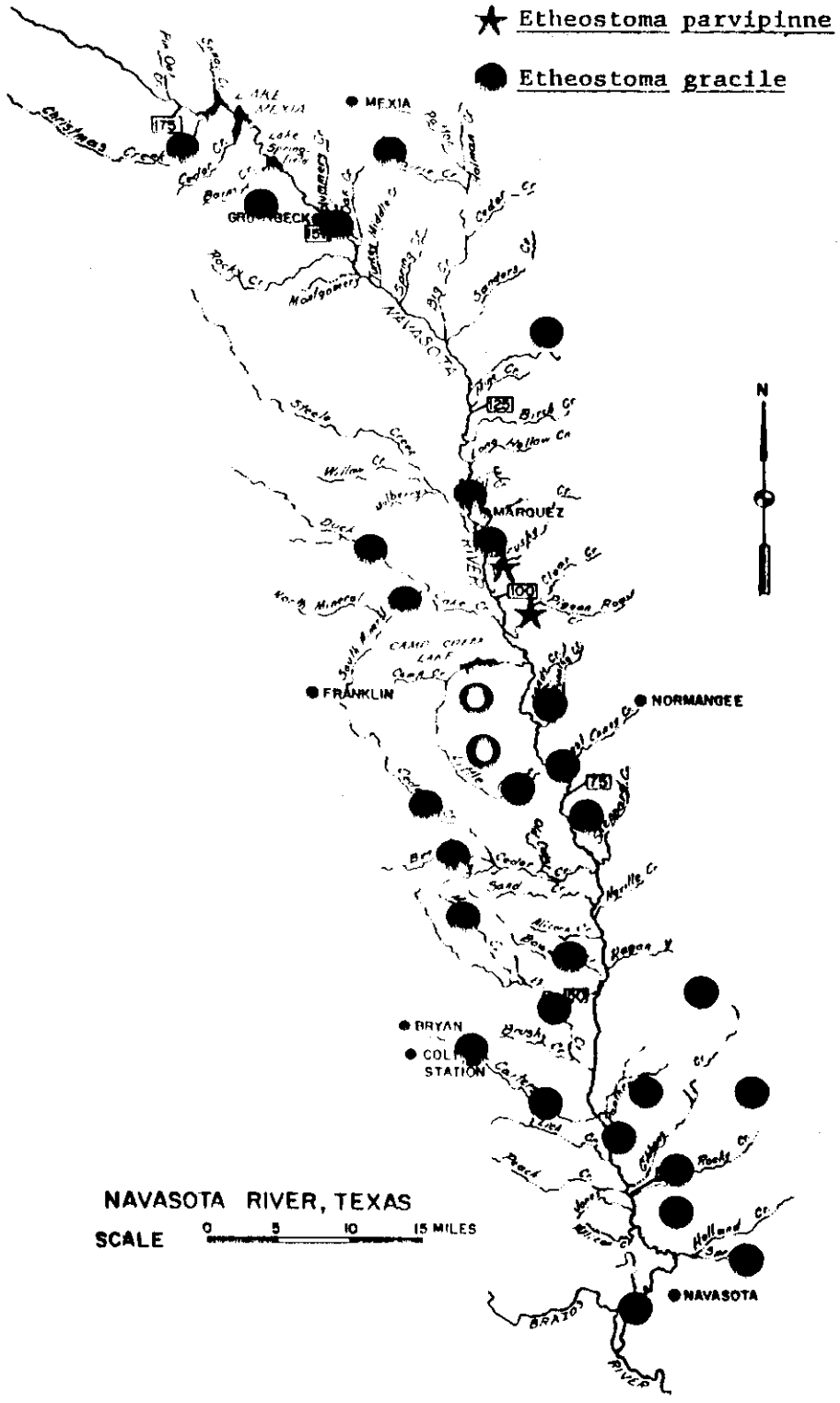
Etheostoma parvipinne
Etheostoma gracile
MEXIA
GROESBECK
MARQUEZ
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NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
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NAVASOTA RIVER, TEXAS
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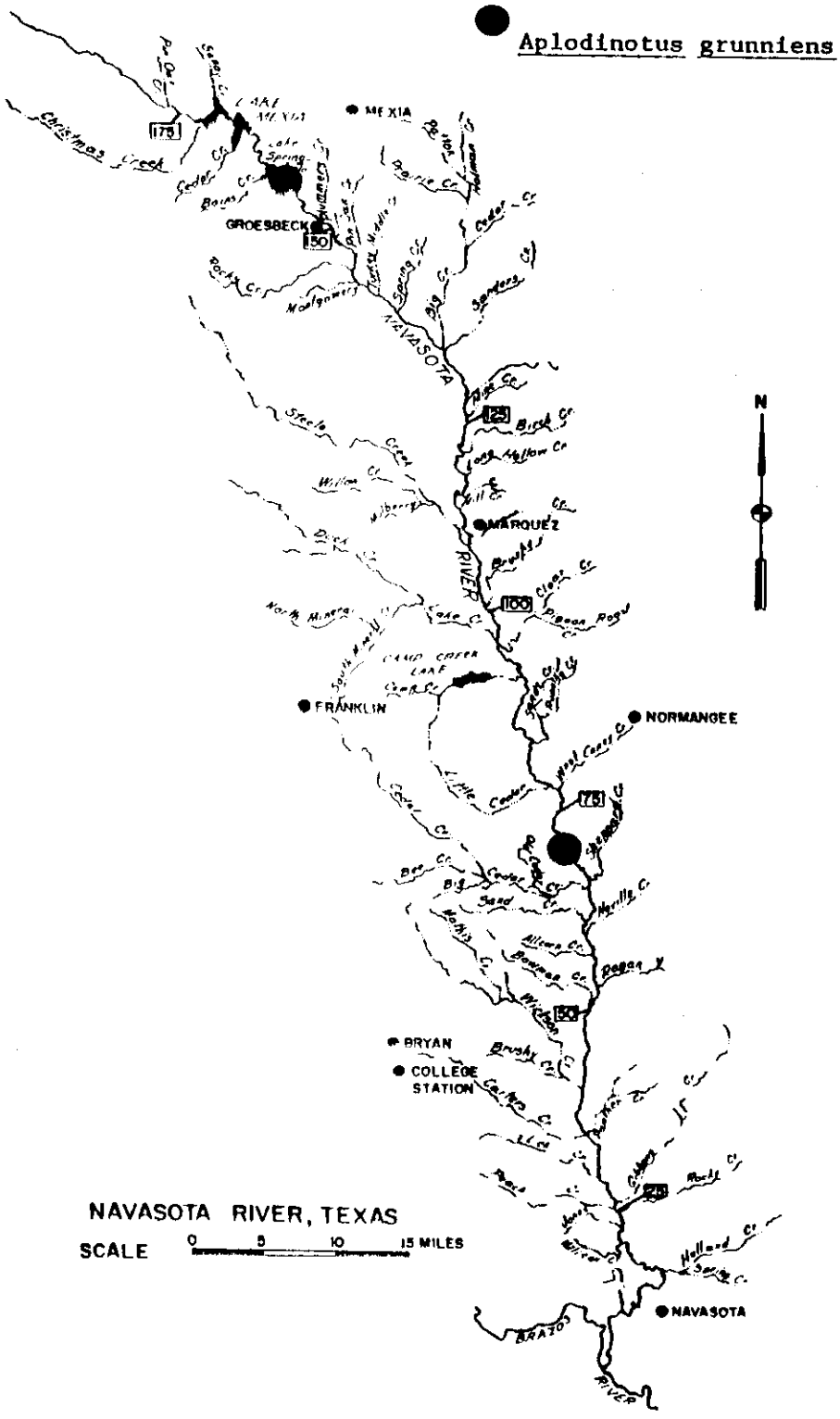
Aplodinotus grunniens
MEXIA
GROESBECK
MARQUEZ
FRANKLIN
NORMANGEE
BRYAN
COLLEGE STATION
NAVASOTA
NAVASOTA RIVER
RIVER
N
NAVASOTA RIVER, TEXAS
SCALE 0 5 10 15 MILES