GEOMORPHOLOGICAL STUDY OF THE TEN MILE DUNES IN RELATION TO THE OLD LOGGING ROAD, INGLENOOK FEN - TEN MILE DUNES NATURAL PRESERVE, CALIFORNIA

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Appendices by William Maslach

Introduction

The Inglenook Fen - Ten Mile Dunes Natural Preserve encompasses 1285 acres of a rare coastal dune ecosystem, wetlands, riparian areas, and the only remaining coastal fen in California, The Ten Mile Dunes have remained remarkably pristine compared to other dune systems on the California coast. However, European beachgrass, an invasive plant has changed the configuration of the foredunes that lie between the old logging road and the beach and has affected the natural dune processes of this preserve, An effort is underway to remove the beachgrass in some areas,

In keeping with the concern of preserving distinct areas of outstanding natural significance, as expressed in the Public Resources Code (Appendix A), a study has been conducted to better understand the long-term effects of geomorphological processes in relation to the old logging road through the Ten Mile Dunes, and to provide a baseline for monitoring the effects of the road on the dunes' environment,

The original alignment of the road was a railroad that extended from the lumber mill in Fort Bragg northward along the coast, through the Ten Mile dunes, then inland along the Ten Mile River where logs were available for transport, In 1949 the railroad was converted to a truck-haul road, in Which form it remained until 1983, when the road was badly damaged and several sections were completely removed by storm waves (articles and excerpts on the history of the road are presented in Appendix D), This area of damage and removal begins about 0.4 km, north of Ward Avenue and extends northward for 1,8 km, Beyond that point the road is essentially intact, except where its surface is being engUlfed by sand,

The study described here emphasizes the intact northern portion of the road, north of the breached area to the Ten Mile River (see Appendix B, map 1), addressing the propensity of future damage to it by storm waves, coastal erosion, sand engulfment, seismic activity and sea-level rise, To provide comparison, the area of the breached and damaged portions of the road in its first 1,8 km, north of Ward Avenue was examined to furnish examples of possible future damage to the presently intact road.'

The accomplishment of this study is based primarily on natural color and color infrared aerial stereophotographs at a scale of 1: 9600 , acquired by State Parks in August 2003. SUbsequent photogrammetry provided topographic maps with a scale of 1:1000 and contoul' intervals of one - half meter (Psomas Company, Sacramento, California). Seven previous sets of aerial photos, ranging from 1952 to 1998, were examined by Pacific Watershed Associates and formed the basis for their analysis of changes in the dunes (PWA, 2000).

Geomorphic Setting

The geological framework of this area is best observed along the stretch of coast 0.8 km. north of Ward Avenue. Bedrock, primarily fractured fine-grained sandstone of the Franciscan coastal belt, is exposed at the foot of the bluffs along the first half kilometer. Softer sandstone and pebbly conglomerate of the youngest coastal terrace directly overlie the bedrock on the bluffs.The mineralogical composition of the terrace deposits and the beach and dune sand are essentially the same, because they are ultimately derived from tile Franciscan bedrock.

From 0.8 km. north of Ward Avenue to the Ten Mile River, beach and dune sand completely cover the terrace deposits and bedrock. Over this first 0.8 km. the bedrock and terrace deposits tilt northward at a gradient of about two percent, as illustrated in Figure 1, an image from the California Coastline Project (2003). They disappear beneath the sand, reappearing 6.5 km. to the north on the bank of the Ten Mile River, brouglIt up by a fault that strikes southeastward along the Ten Mile Valley (Jennings, 1994). A Magnitude 4.1 earthquake occurred on this fault in January,1999.

Sand *Movement*

The Ten Mile Dunes comprise three major lobes, termed north, middle, and south. The north lobe is the largest in area; the south lobe is the next .largest, and the middle lobe is the smallest. Low·lying pasture land drained by Inglenook Creek separates the north and middle lobes, and the creek draining Sandhill Lake separates the middle and south lobes. Fox and Barry in the volume "Inglenook Fen, a Study and Plan" (1977) point out that the Ten Mile

[1] An example of incipient road damage is seen a few meters north of the Ward Avenue gate, where **the western edge of the road is being impinged upon by erosion of the bluff. Removal of terrace deposit sandstone by storm *wave* action, exacerbated by the creek flowing north along the base of** the bluff, and fresh water seepage in the cliff face, is causing the bluff to erode into the form of **a near-vertical cliff over a length of about 20 m.**

Figure 1. A cliff in terrace deposits, about 6 m. high in the right side of the photo, tilting northward over a distance of about 250 ffi. where it is engulfed by sand. California Coastline Project oblique aerial image: 11369.jpg.

Dunes are principally transverse dunes, with steep precipitation ridges resulting from "moderate one-directional winds that move only light sand." A wind rose in that compendium indicates that the prevailing direction in summer ranges from northwest to north-northwest, with an average speed of ten miles per hour. Lighter winds from the southeast prevail in winter. The August 2003 aerial photography, especially the infrared photos, shows a scalloped pattern of the transverse sand ridges in the three dune lobes, generally at right angles to the prevailing northwesterly wind direction.

The principal source of sediment for the dune sand has been and continues to be the Ten Mile River. An additional sand source is erosion by *wave* action on bedrock cliffs north of the river, and a small component of sand results from wave erosion of terrace deposits that are exposed within the half mile north of Ward Avenue. The main direction of coastal-current sand transport is from the Ten Mile River southward, but localized south-to-north currents may also transport sand from the southerly source areas.

The road serves as a useful "benchmark" in determining net accretion or removal of sand. Shortening over time of the road-to-beach distance indicates that the combined effects of wind transport and wave erosion are removing the westerly edge of the dunes, while an increase of the road-to-beach distance indicates an accretion of sand between the road and the beach.

Graphs in the Pacific Watershed Associates report (PWA, 2000) show that over the three kilometers north of Ward Avenue, from 1952 to 1998 there was significant shortening of the distance between the road and the beach, in some areas as much as 35 to 40 m. Farther north, between 3.9 and 5.4 km., the distance between the road and beach increased. This pattern generally holds over the shorter time interval 1986 to 1998, except that the road-to-beach distance has increased at some locations between 1.8 and 2.4 km. north of Ward Avenue. Scaling the road-to-beach distances from the August 2003 topographic maps (Table 1) indicates that between 1998 and 2003, the dunes continued to accrete sand north of 2.9 km., there was essentially no change in road-to-beach distance at 2.5 km., it decreased over the half kilometer south of there, and it alternately increased and decreased southward from 2 to 0.8 km. north of Ward Avenue. The above suggests that within the past *five* years, over the distance 2.5 km. north of Ward Avenue, the dunes west of where the road is intact continue to diminish in places, while north of 2.5 km, the dunes continue to accrete sand. A series of land-surface profiles has been formulated by computer processing of

Table 1. Change in distance between road and beach

Location N. of Ward Av. (km.)	Change 1998-2003 (m.)	2003 Scaled Dist. (m.)
0.84	8	-12
1.14	-3	-10
1.44	5	10
1.8	-10	-5
1.96	10	20
2.18	-15	20
2.3	-2	43
2.36	-5	64
2.5	0	105
2.94	5	80
3.32	2	126
3.88	12	45
4.62	1	26
5.36	10	70

the stereophotographic data, and is presented in Appendix B. These profiles will serve as references for future surveys.

The engulfment of the road by blown sand is occurring in two nearby zones on the north limb of the curve of the road, where the road alignment is essentially at right angles to the prevailing northwesterly wind direction. The principal engulfment extends over a road length of 90 m. It is separated to the west by 20 m. of clear road from a 13 m. -wide sand zone. Where the 90 meters of road are buried, thickness of the sand ranges up to 1.5 m.; it is banked there on the downwind side of the road. William Maslach (Ecologist, California State Parks, personal communication) reports that not more than one attempt has been made to clear the sand from the road for several years. It is important to note that upwind of this north-curve portion of the road, there is the greatest distance between the road and the beach, over 300 m. This provides a substantial source of sand for continuing engulfment of the road. Within the first 150 m. of that distance, there is a marked depression in the dune terrain, suggesting a zone of ablation of sand, with its product banking against and over the road.

Over the past few years, and continuing today, beach grass has been removed manually from the strip of dunes between the road and the beach over a distance of 1.6 km. north of the Inglenook Creek crossing. Where grass removal has occurred, the height and irregularity of the dunes is markedly lower than where removal has not been conducted. Though a significant quantity of sand has blown across the road as a result, and small stringers of sand extend onto the west side of the road, the road is by no means inundated in that area.

Overwash Deposits

There is abundant evidence that storm-generated waves, coupled with high tides, have washed over the road. Wood debris, ranging in size from a few decimeters in diameter to conifer logs over a meter in diameter and several meters in length, have been deposited east of the road along its northern 3.8 km. This size distribution is similar to that presently observed along the beach. The landward edge of the distribution of the zone of wood debris was mapped with a hand-held global positioning satellite unit, as illustrated and described in Appendix C. Debris are distributed from near roadside, where it parallels Fen Creek, to over 200 m. inland, about 1 km. south of the Inglenook Creek crossing where the road is no longer intact. Along the portion of road north of its easterly jog one half km. north of the Inglenook Creek crossing, the zone of wood deposits is of the order of 30 to

80 m. in width. It continues northward to the beginning of the north curve; beyond that point, overwash deposits occur seaward of the road. Observations of standing water in low-lying areas immediately east of the road during a period of heavy rain in December 2003, suggest that logs transported over dune terrain and the road by storm waves at high tides would have been pushed eastward by wind in these shallow lagoons until they were stranded. That this much wood debris was carried across the road attests to the robustness of the road north of Fen Creek in withstanding at least one, and most likely several, short-lived inundations.

Sea Level Rise

A critical factor in determining the geomorphology of the foredune is the effect of rising sea level in response to ongoing global warming. The two main causes of sea level rise are the addition to the oceans of melt water, primarily from the Antarctic and Greenland ice sheets, and expansion of the ocean due to heating of its water. Over the past 18,000 years, since the depth of the most recent ice age, sea level has risen about 100 m. The present-day rate of sea level rise is 2.5 mm per year. This rate is expected to increase in response to increased atmospheric warming caused by anthropogenic greenhouse gas emissions; an enhanced rate of 4.2 mm per year was predicted in 1995 (Titus and Naryanan, 1995) and was confirmed by Leatherman et al. in 2000. By mid century, this rate would lead to a sea level rise of over 0.2 m. Leatherman et al. (2000) point out that on Atlantic coastal beaches, for each unit of sea level rise the zone of erosion reaches inland 100 to, in some cases, 200 times that unit, Thus for a 0,2 m. rise, the zOl1e of erosion could conceivably extend up to 40 m, farther inland than it is today.

Vigorous wave action is generally more continuous on the Northern California coast than on East Coast beaches, Therefore, for Ten Mile Beach, of similar topography to beaches studied by Leatherman et al., the "zone of erosion" factors might be greater than on East Coast beaches, (It is noted that the distance from the point of closest approach of the west edge of the intact road, at a location 1.1 km. north of the Inglenook Creek crossing, to the high-tide "froth line" on a stormy day in December 1993 was 40 m.) It is clear, then, that overwashings of the road as have occurred occasionally in the past five decades, will become more frequent over the next several decades as sea level continues to rise at an accelerated rate. As the distance between the beach and the road is reduced in response to accelerated sea level rise, more vigorous wave attack on the road and its adjacent berm will ultimately lead to destruction of portions of the road presently closest to the beach, Other highly vulnerable areas are those adjacent to the stream crossings of Inglenook and Fen creeks, where wave attack and overwashing would damage, if not completely destroy, the culverts presently conducting those creeks under the road,

Possible Removal of Culverts

Two 5-foot-diameter corrugated steel culverts, one at a distance 2,5 km, north of Ward Avenue, one at 3.4 km" conduct Fen and Inglenook creeks, respectively, under the haul road, The culverts were emplaced as substitutes for trestles before the haulage converted from rail to log trucks, Future management of the Ten Mile Dunes Preserve may consider restoring natural stream porcesses by removing the culverts,

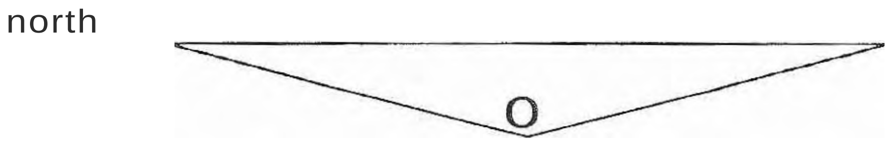
The Inglenook Creek culvert, approximately 60 feet long, is presently partly blocked by a -2 ft, diameter log lying parallel to and completely within the culvert in its upstream portion, Despite the presence of this log, the culvert appears to be in good condition, and was conducting a midsummer flow of - 1/3 cubic ft, per second in late July 2004, The Fen Creek culvert, also 60 ft, long, was completely open but dry at tllat time, About 6 ft, of each end of the Fen Creek culvert protrudes from the fill, and these protrusions are strongly corroded, Both culverts are oriented at angles to the road alignment, so that almost their full lengths are encompassed by the road Fill, The inverts of both culverts are at the grade of the stream thalweg,

The Fill includes old trestle pilings, attesting to the fill-construction process of removing decking and stringers and dumping rock from railway cars directly into the trestle's substructure (Eugene Lewis, private communication), At Inglenook Creek, the downstream face of the fill has been armored by emplacement of salvaged concrete pieces several feet on a side, The presence of large tree trunks and logs in the channels downstream of the culverts demonstrates the effectiveness of winter storm surge/wave action in transporting large debris inland to the road,

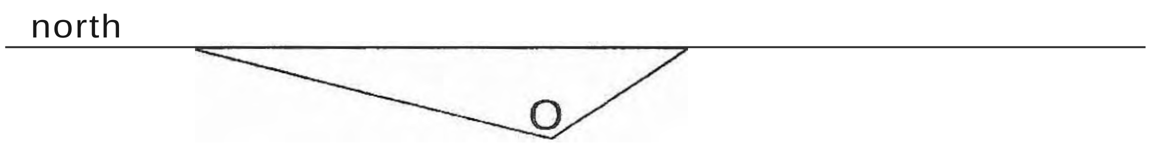
In considering the possibility of removing the culverts and reopening the stream channels, the amount of fill to be removed must be taken into account: the resulting open slopes in the exposed old fill should introduce as small an amount of sediment into the streams as practicable, In this respect, slopes of 3,5:1 in the fill should suffice, extending the excavation out to approximately 40 ft, from the centerlines of the culverts (see Fig. 2), An exception to this configuration would be the fill south of the Fen Creek culvert, where the distance from the centerline to the "natural" sand surface is only 15ft. Calculating volumes of fill material (excluding the volumes of the culverts) that would be removed, based on these configurations yields approximately 600 cubic yards for the Inglenook Creek crossing and ~300 cubic yards for Fen Creek.

The disposal of this ~900 cubic yard volume of fill must also be taken into account when weighing the pros and cons of culvert removal. Operations would require access of an excavator and large trucks to the haul road, necessitating the removal of sand presently being allowed to cover the road's north curve. Removal of fill at Inglenook Creek would disrupt a portion of a thick growth of willows that covers both sides of the present road berm. This thicket extends over 100 feet upstream and completely covers and shades the creek in that area. The large concrete pieces on the fill at Inglenook Creek and a significant volume of timber pilings in both fills would complicate excavation, haulage and disposal. Additional considerations for addressing the restoration of natural processes may include stream meander, pool structures, and riparian vegetation before and after the construction of the haul road berm and culverts. European beach grass may have played an important role in sculpting the topography near the mouths of the streams.

Inglenook Creek



Fen Creek



Scale: 20 ft,

Effects of the Road

North of Fen Creek, the dunes seaward of the road, though small, have a more rugged relief than the flatter, smoother, and at some locations lower, sand area immediately east of the road. This change in dune topography probably results from the nearly century-long presence of the railroad / road aligment. Its base course and sUbgrade of crushed rock have likely acted as a manmade berm where sand accumulates on the upwind side and ablates immediately downwind. While it was a commercial haulage way, continuous efforts to clear sand iikely deposited the sand downwind. The present-day removal of European beach grass along the seaward side of the road is causing a marked diminishment of the height and "topography" of the dunes in that strip.

On the north curve of the road where its alignment is nearly perpendicular to the prevailing wind direction and sand is not being removed, the sand accumulating on the road is essentially erasing the road's effect on dune topography. On the long straight stretches of the road, however, the road's direction is much closer to the prevailing wind direction, so that sand will continue to be naturally scoured from the road and will not accumulate as readily as on the north curve.

Seismic Setting

The principal seismic concern is that liquefaction will occur on the beach and in the dunes in response to prolonged shaking where hydrological conditions are at or near saturation. The dunes/road area is close to the San Andreas Fault, strands of which roughly parallel the coast 7 to 15 km. offshore (Jennings,1994; McCulloch,1989). A maximum credible earthquake on the San Andreas would be a repeat of the April 18, 1906 event of MagnitUde 8, where Modified Mercalli intensities of 9 were experienced at Fort Bragg and Inglenook. Liquefaction-caused subsidence and/or tilting of the roadway should be expected where the road crosses or closely parallels Inglenook and Fen creeks, because these zones are perennially saturated. The dunes would be subjected to less intense shaking from an earthquake on the Maacamas Fault, whose area of closest approach is 25 km. (16 mi.) to the east, and where the expected maximum magnitude is less than on the San Andreas Fault. However, based on observations in the San Francisco Bay Area following the 1989 Magnitude 7 Loma Prieta earthquake, liquefaction in the Ten Mile dunes is possible in respone to an earthquake of comparable magnitude on the Maacamas Fault.

Of similar concern to an earthquake on the San Andreas or Maacamas faults is the area's response to a large subduction-related earthquake near the Mendocino triple junction, about 100 km. to the northwest. Along with shaking and accompanying liquefaction, there is the added factor of a tsunami resulting from submarine landsliding on the Mendocino escarpment.

Summary and Conclusions

The Ten Mile Dunes are a dynamic setting, incorporating dune migration, storm wave action, sea-level rise, and seismicity: all factors that have affected, are affecting, or will affect the old logging road that passes along their western margin. The southern portion of the road within the 1.5 km. north of Ward Avenue has already been removed and damaged by storm wave action, coupled with the effects of fresh water creeks and seeps. In its north portion where the road is perpendicular to the prevailing wind direction, it is being engulfed by sand. Farther south, where the road more nearly parallels the wind direction, it is fairly free of sand, though removal of dune grass and the resulting reduction of roadside dunes may Ultimately cause the road to be engulfed in that area. Presently, the overall distance between the road and the beach is increasing in the northern portion of the area as sand accumulates; to the south, the road-to-beach distance is decreasing,

A ~4 km. straight stretch of the road and its predecessor railway have been overwashed several times by high storm waves, evidenced by deposits of logs well inland of the road. To date, the road has withstood these short-term inundations. Overwashing is expected to occur more frequently during the next half century as sea level rises in response to global warming,

The road/railway alignment has been in place long enough to have had its effect on the dunes, in that it has served as a berm, trapping sand on its upwind side and providing a low-relief ablation zone on its downwind side. Two creeks transecting the dunes have been conducted under the berm by culverts, These effects will gradually be erased if sand is allowed to engulf the road and the culverts are removed,

Liquefaction in response to strong shaking from a large earthquake on the San Andreas or Maacamas faults, or at the Mendocino triple junction will probably cause the road to tilt or subside in areas that are permanently saturated, especially where the road crosses Fen and Inglenook creeks,

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Figure Captions

1, A cliff in terrace deposits, about 6 m, high in the right side of the photo, tilting northward over a distance of ~250 m. where it is engUlfed by sand, California Coastline Project oblique aerial image 11369,JPG,

2, Schematic cross sections of wedges of fill to be excavated if culverts are removed at Fen and Inglenook creeks,

APPENDIX A

CONTOUR PROFILES OF THE FOREDUNES OF THE INGLENOOK FEN/TEN MILE DUNES NATURAL PRESERVE

prepared by

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April 2004

Contour profiles have been created using a tool developed for ArcGIS Desktop (Huang 2004). A graphic line is drawn over the contour layer to produce a profile. The tool uses the elevation value of each topographic line it crosses as Y vales for the graph. The distance of the graphic line is plotted as the X values for the graph.

To maintain consistency for repeatability, profile lines are always draw from due west to due cast. Lines begin at the westernmost contour line (usually 2.5') and continued due east 25 meters past a point on the haul road. Maintaining a standard distance of25 meters allowed for easy visualization of where the haul road exists on the contour profile graph; it is always 25 meters west ofthe eastern end of the transect. Lengths of the transects vary because the distance from the center of the haul road to the water's **edge varies.**

TOPOGRAPHIC PROFILE RESULTS

Results of the profiles are displayed as graphs on maps showing the locations of the transects. Coordinates of all points are in UTMZone 10, NAD83 and lengths of transects are indicated in Table 1.

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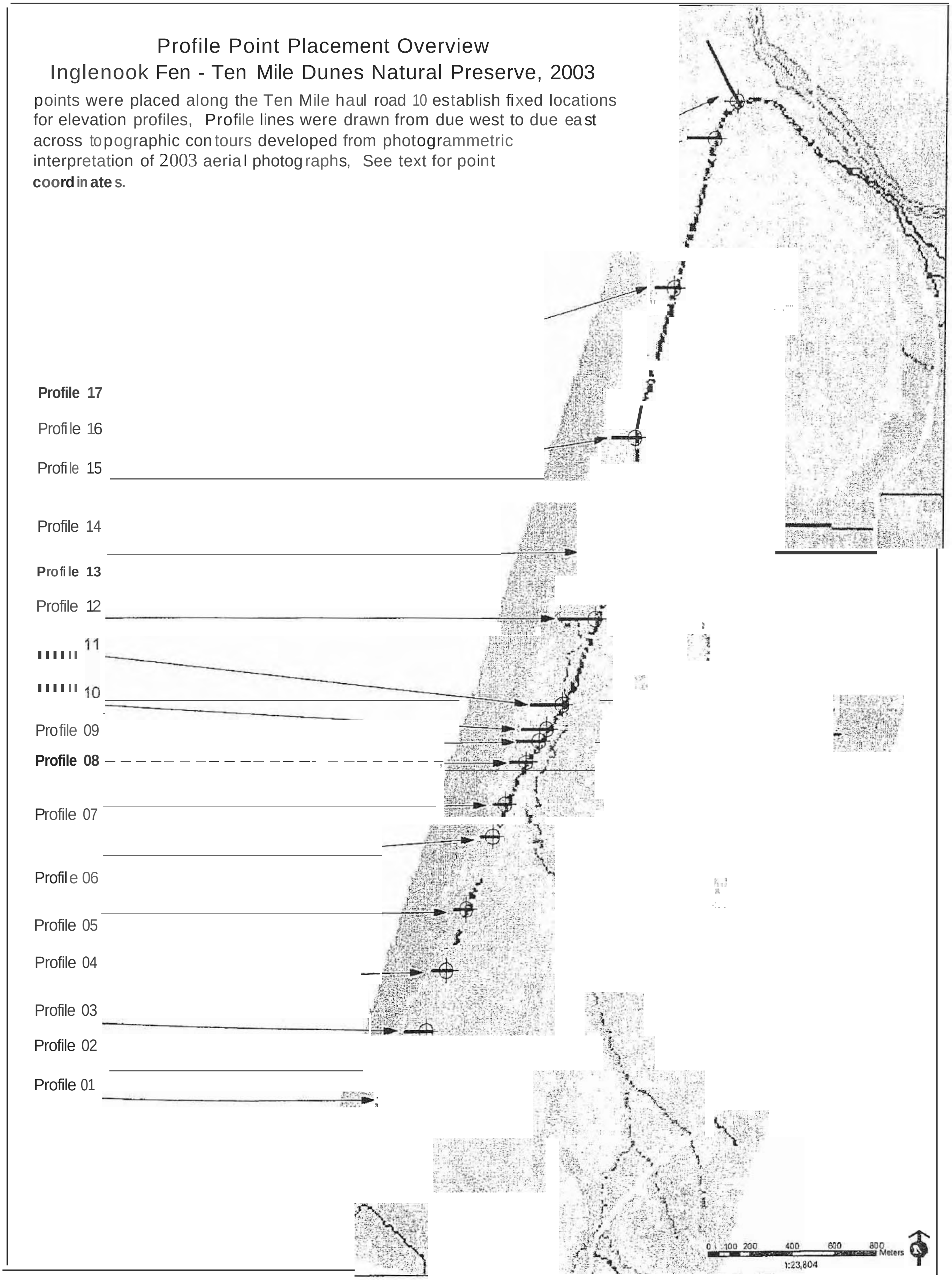
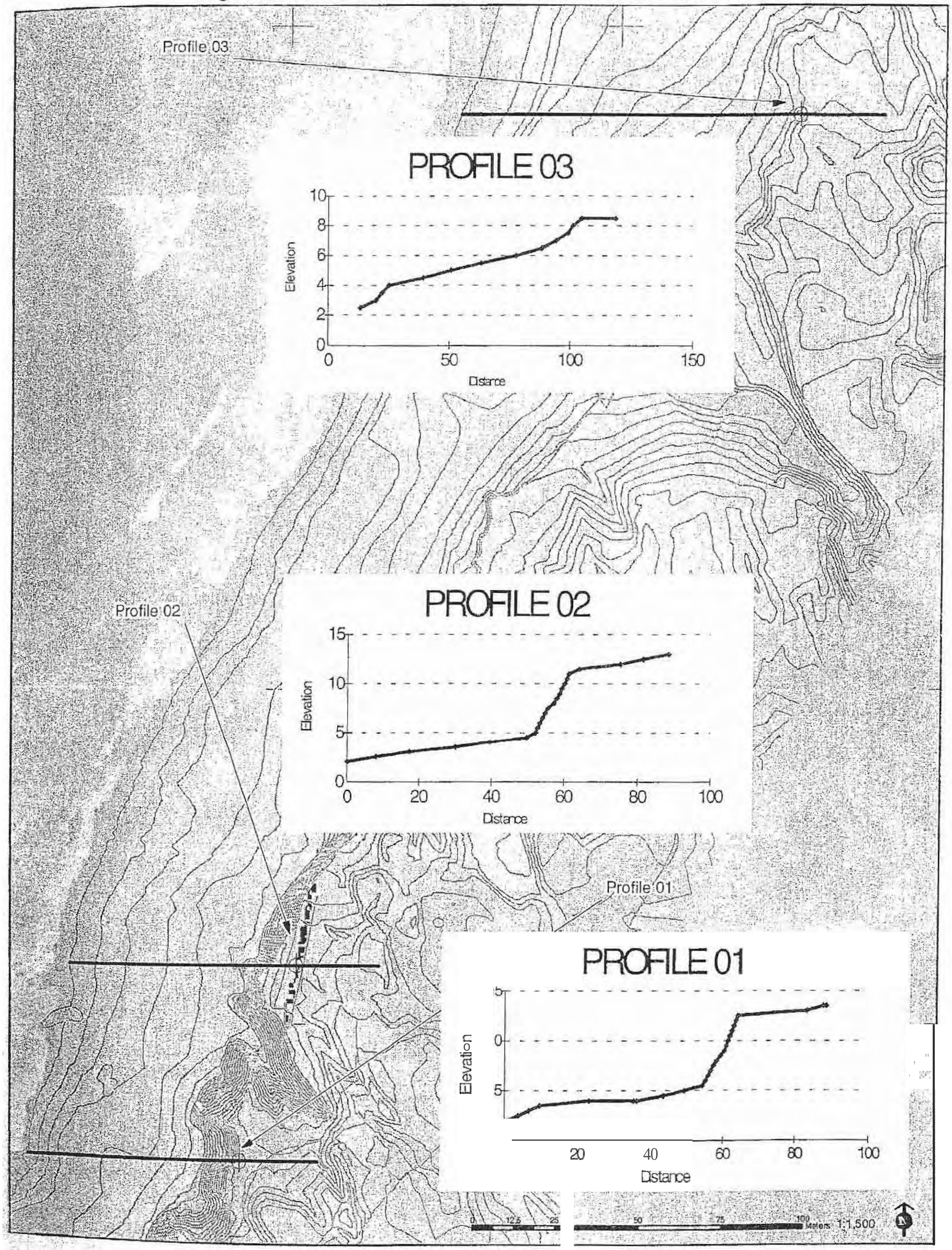
Profile Point Placement Overview
Inglenook Fen - Ten Mile Dunes Natural Preserve, 2003

points were placed along the Ten Mile haul road 10 establish fixed locations for elevation profiles, Profile lines were drawn from due west to due east across topographic contours developed from photogrammetric interpretation of 2003 aerial photographs, See text for point coordinates.



Elevation Profiles
Inglenook Fen - Ten Mile Dunes Natural Preserve, 2003



Elevation Profiles

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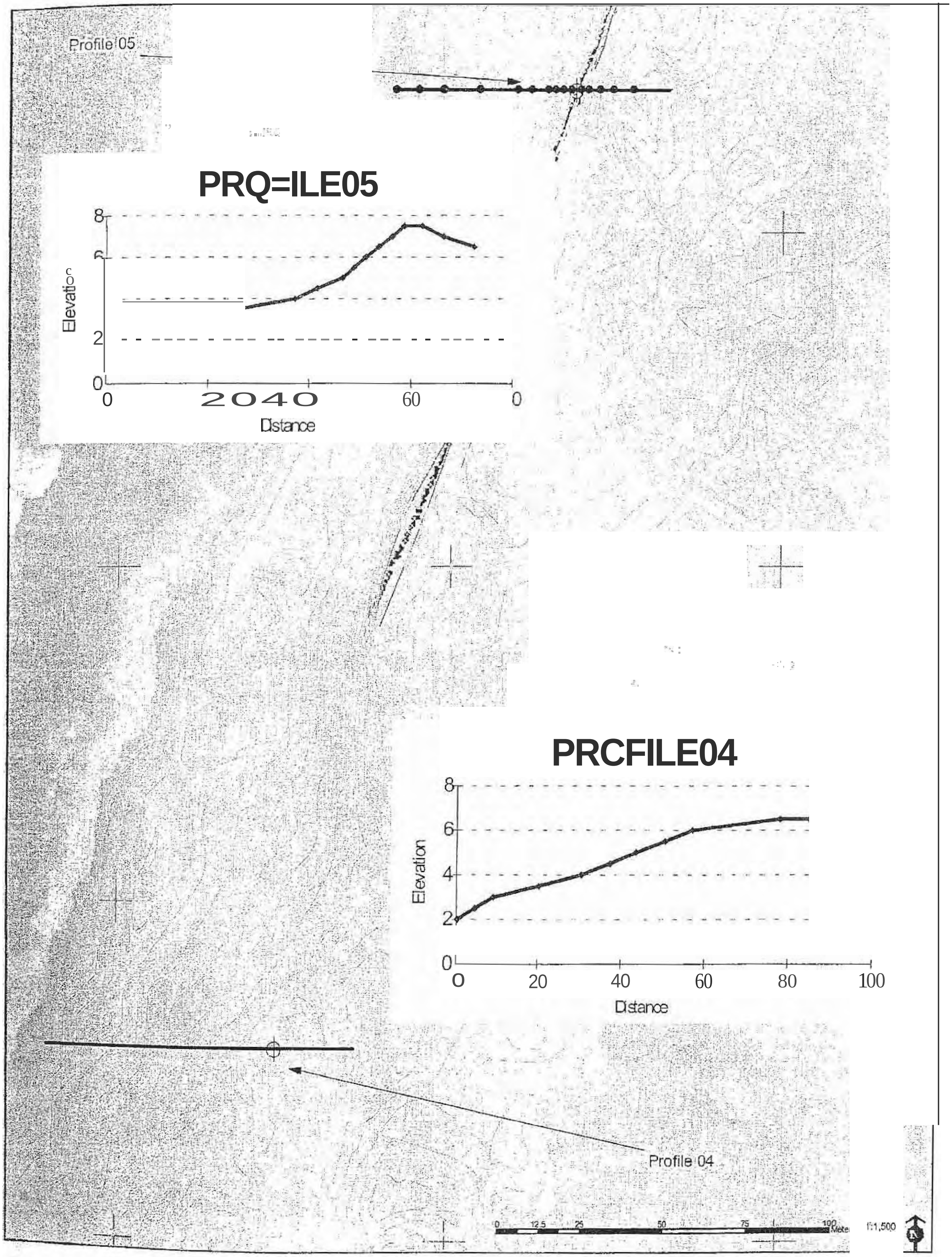
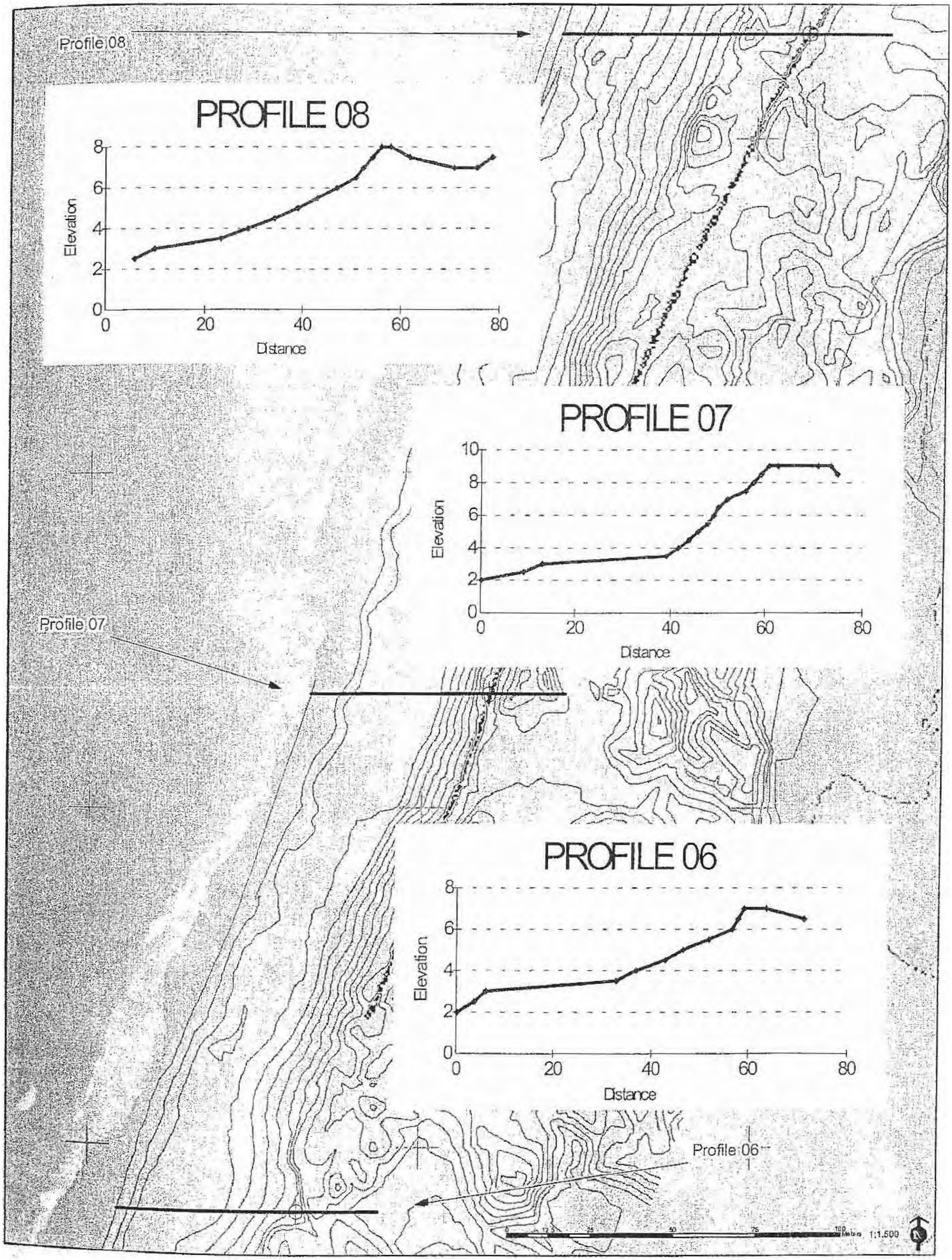


Elevation Profiles

Inglenook Fen - Ten Mile Dunes **Natural** Preserve, 2003



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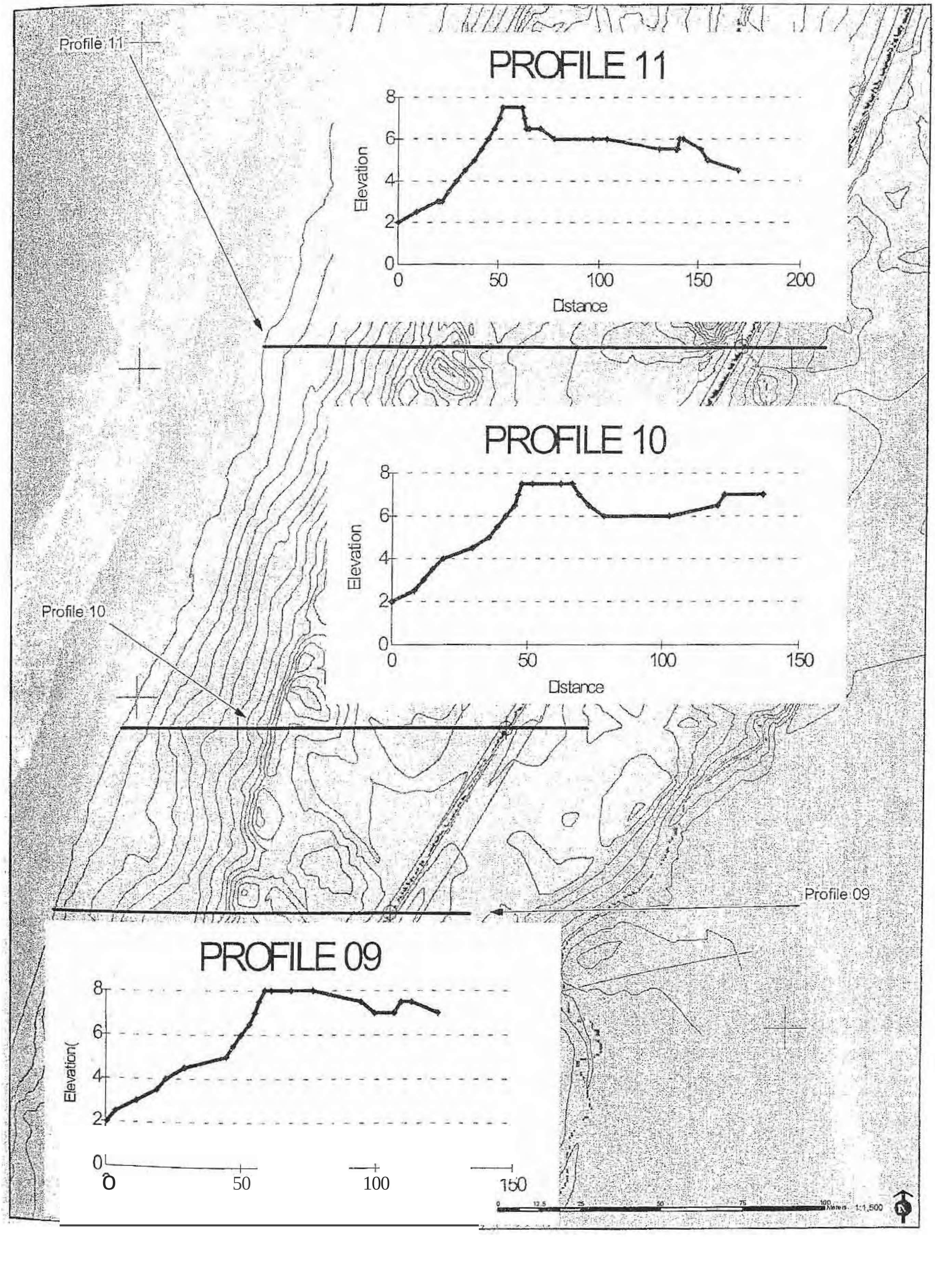

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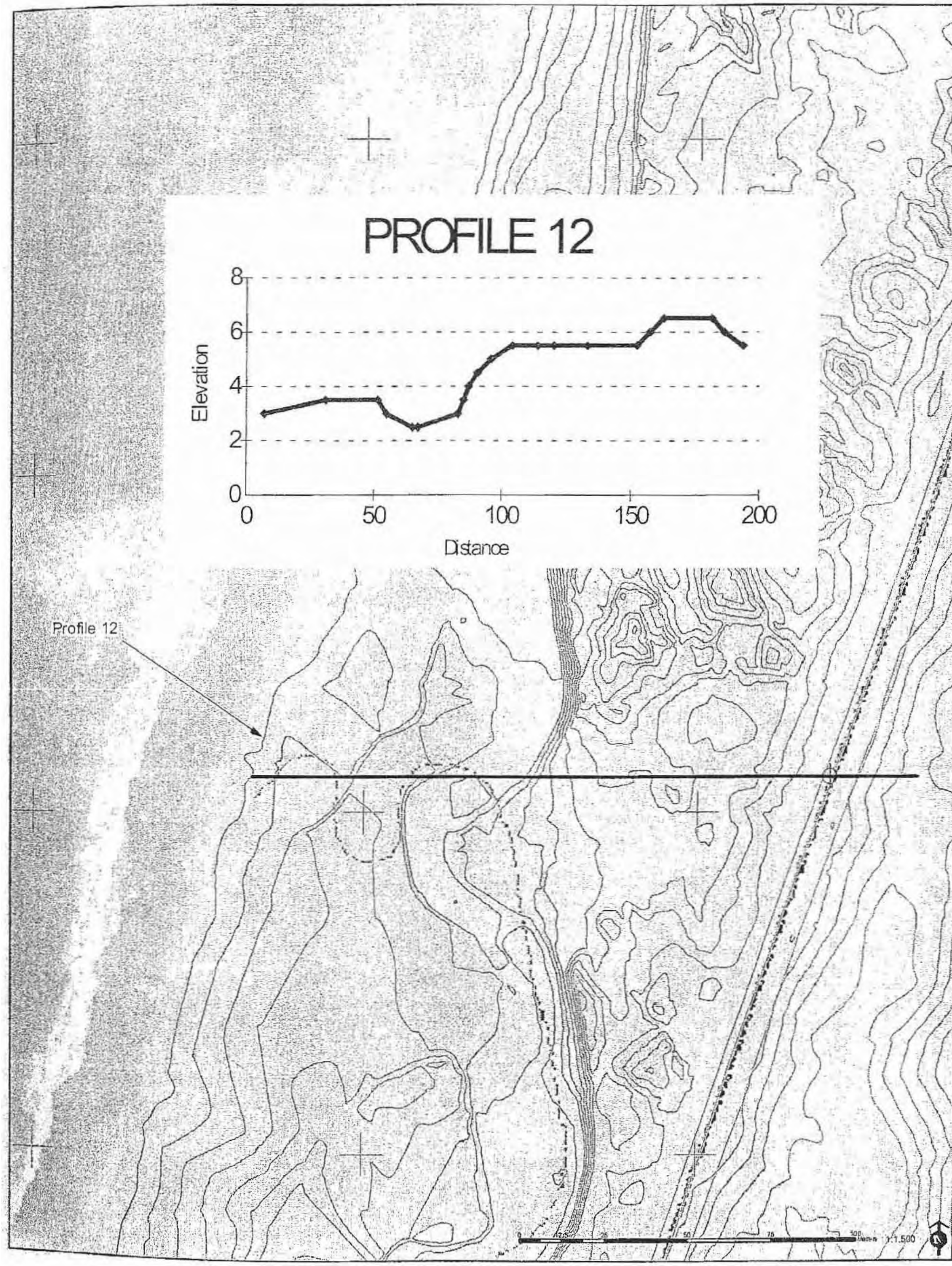

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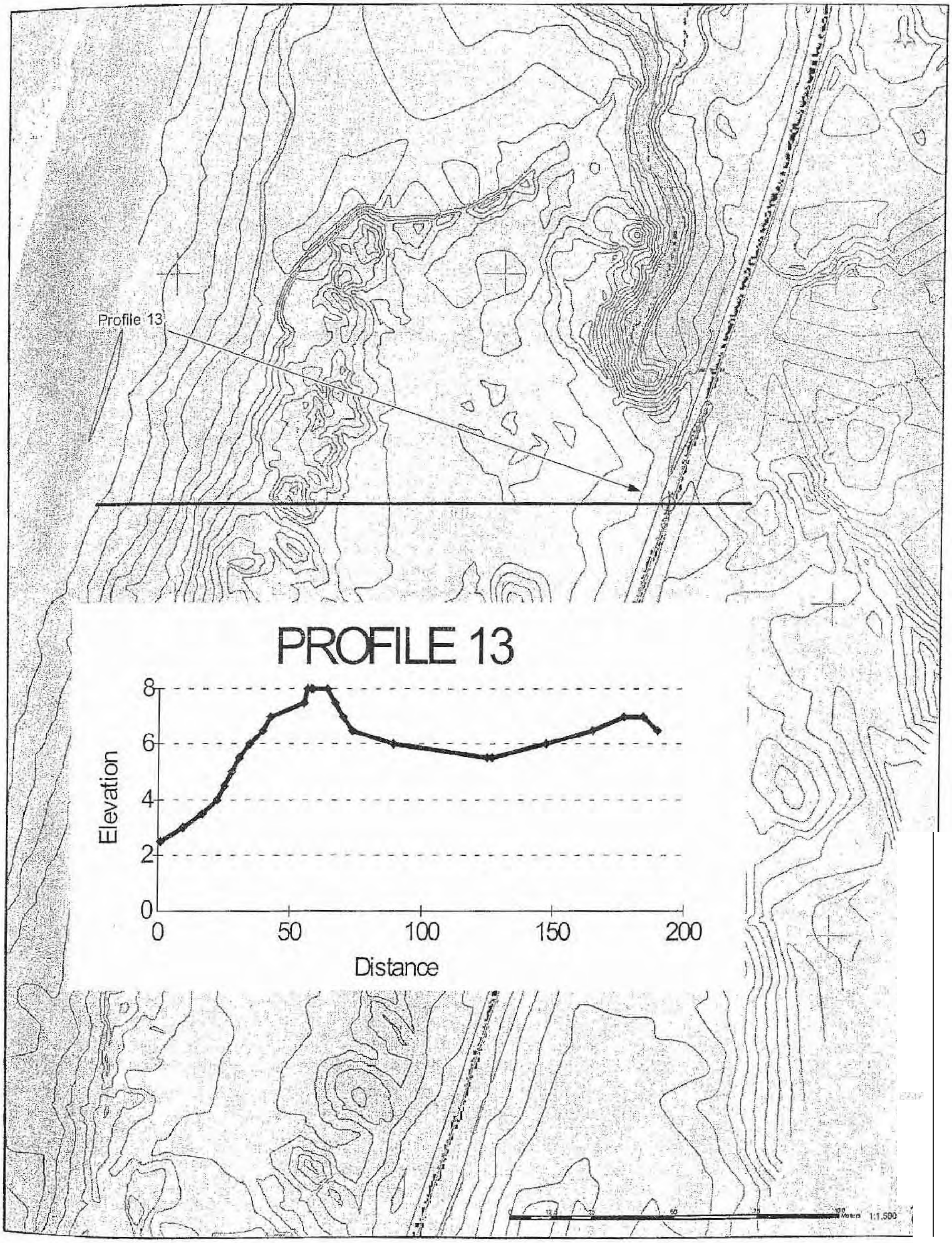

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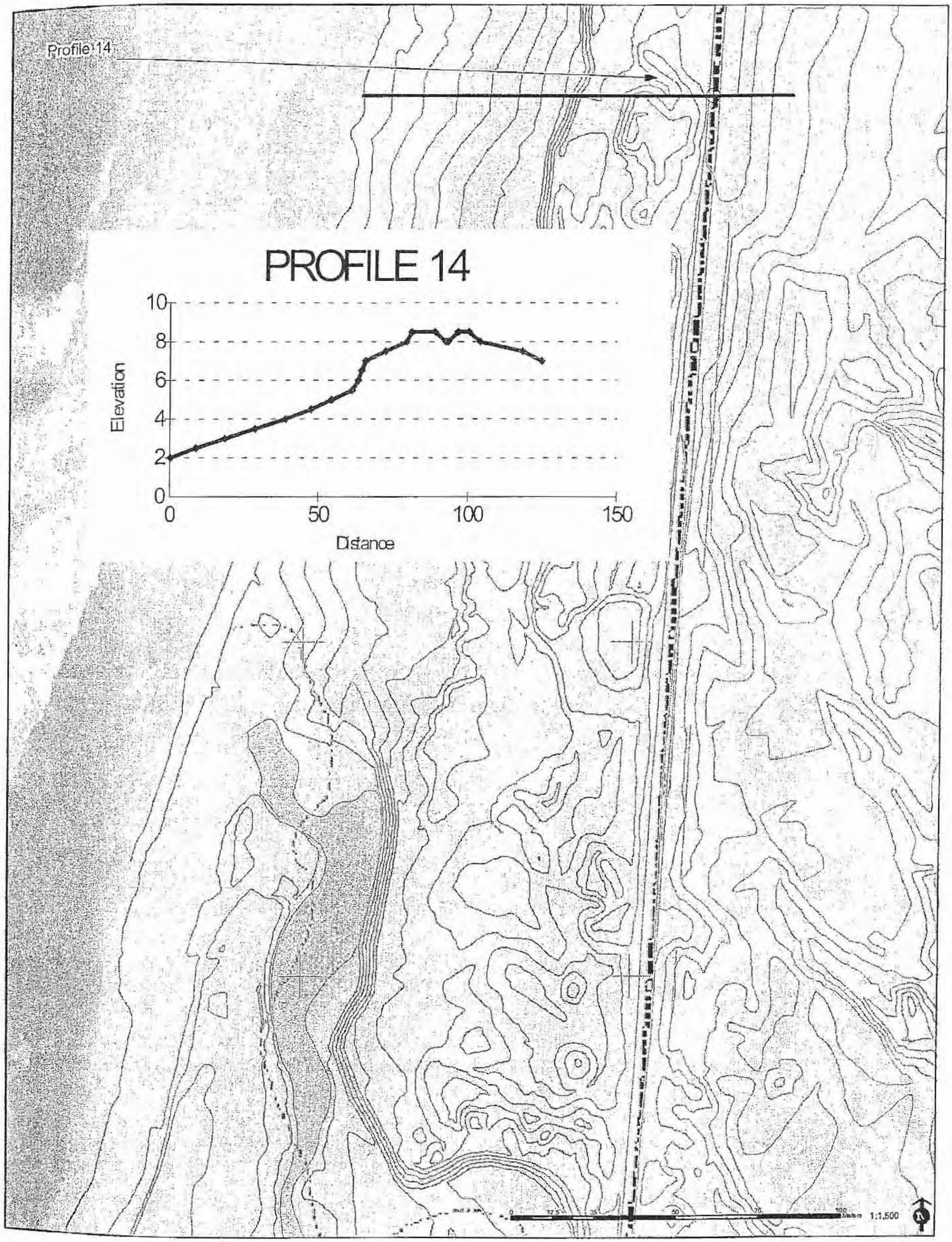
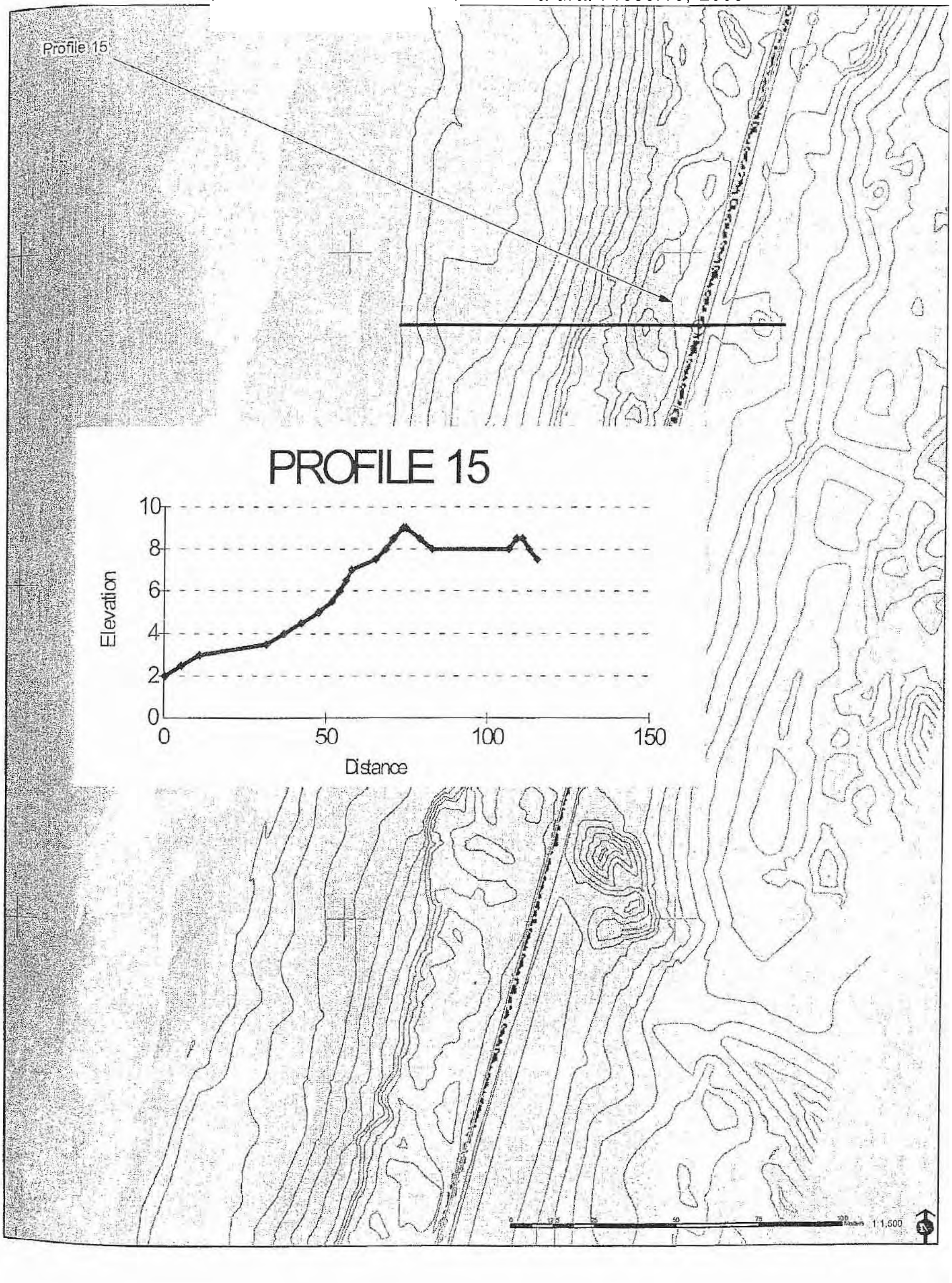
Inglenook Fen · Ten Mile Dunes Natural Preserve, 2003



Inglenook Fen - Ten Mile Dunes Natural Preserve, 2003
Elevation Profiles



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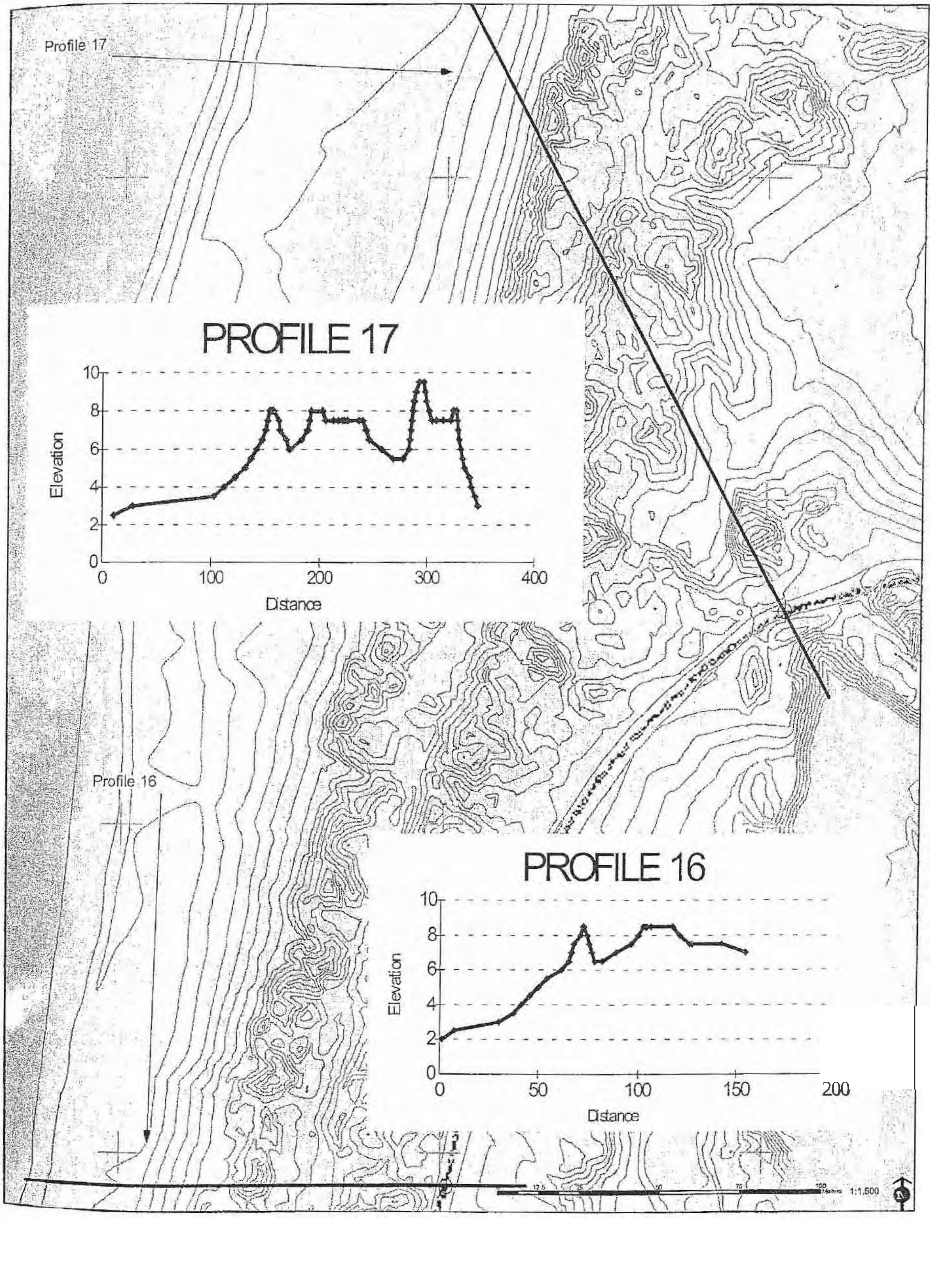
Inglenook Fen- Ten Mile Dunes Natural Preserve, 2003



APPENDIX B

WAVE-DEPOSITED WOODY DEBRIS MAPPING IN THE INGLENOOK FENITEN MILE DUNES NATURAL PRESERVE

prepared by

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April 2004

DISCUSSION

The mapped line of easternmost wave-deposited woody debris shows the extent of ocean wave influences in the dunes from the Ten Mile River to approximately 700 meters nOlih-northeast of the intersection of the Ten Mile haul road and Ward Avenue. Along this 5 kilometer stretch of beach, the average distance of the wave-deposited woody debris in the easternmost areas to the mean high tide line is approximately 150 meters, excluding the areas south of Inglenook and Fen Creeks, where the distances are greater. The greatest eastward distance of deposited woody debris is 310 meters in an area south of Inglenook Creek. Here, the deposited wood is approximately 50 meters from north to south and may be **from an isolated wave surge in a topographically low dune swale. The largest area of wave influence is** south of Fen Creek where the debris is 290 meters eastward from the mean high tide line and is spread from nOlih to south for 445 meters. Interestingly, the al'eas of greatest wave influence as interpreted by woody debris deposit are both south of the two major creeks, Fen and Inglenook, that run through the sand dunes.

An overestimated measure of distance of wave influence may occur in some of the mapped areas. Where debris-laden waves have surged into topographic depressions filled with rainwater runoff, the debris may have floated to the edges of these pools without necessarily being deposited by waves. This may have occurred in the areas south of Inglenook Creek and Fen Creek, the latter being the greatest area of debris deposit. A large pond at least 0.5 meters deep regularly forms after heavy rains in this area, and in 1999 a 30 meter wide blowout was mapped after the pond had breached the Ten Mile haul road berm.

The age of some of the woody debris is likely decades old. Figure I is a photograph of a piece of wood found in the dunes that shows exposure to wind erosion. Many of the larger pieces of wood are well ensconced in the sand and some have mature dune plants growing in crevices in the logs, indicating they were not recently deposited. Years of large storm events are likely when the easternmost debris was deposited, such as the winter of 1983.

Nearly all of the European beach grass as mapped from 1998 aerial photographs exists west of the wave-deposited woody debris line. The spread of beacll grass may be, in palt, due to the periodic surge of ocean waves into the foredune system.

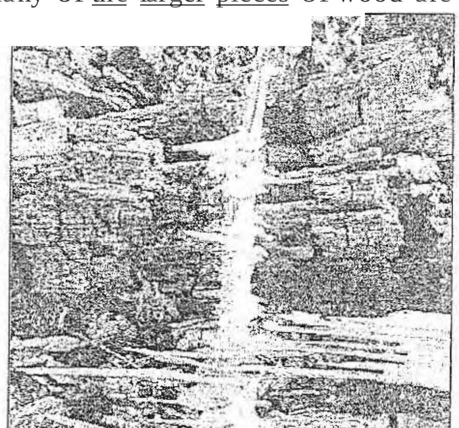


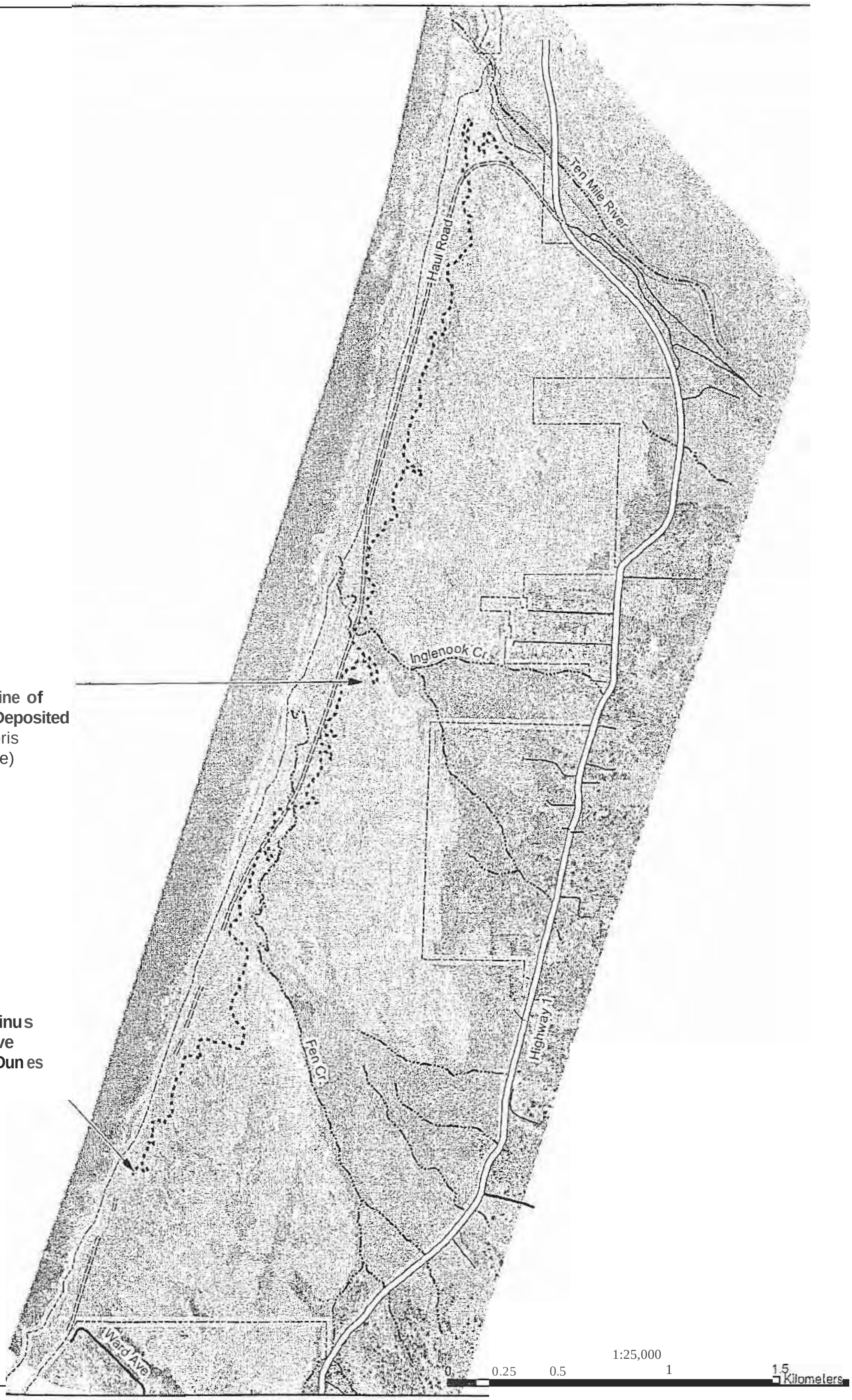
Figure I. Photograph of A Piece of Wood **with Exposure to Wind Erosion Against A Larger Rotting Log.**

CONCLUSION

Evidence for the easternmost extent of ocean waves in the Ten Mile dune system is based on mapping of the current distribution of woody debris in the dunes. Pieces of wood are usually distributed in a line much like debris is deposited at a wrack line or lake edge, supporting the idea that the observed woody debris has been deposited by ocean waves. In a few areas of large topographic depressions such as swales and dune slacks, rall1 water may have accumulated to form a pond where woody debris could have floated to the easternmost edge. In these areas the easternmost extent of ocean wave influence may be overestimated.

The extent of influence of ocean waves into the dunes for approximately 150 meters above the mean high tide line illustrates the dynamic nature of a coastal dune system. Periodic large storm events contnbute to the formation as well as the erosion of the sand dunes. Ocean waves bring organic material

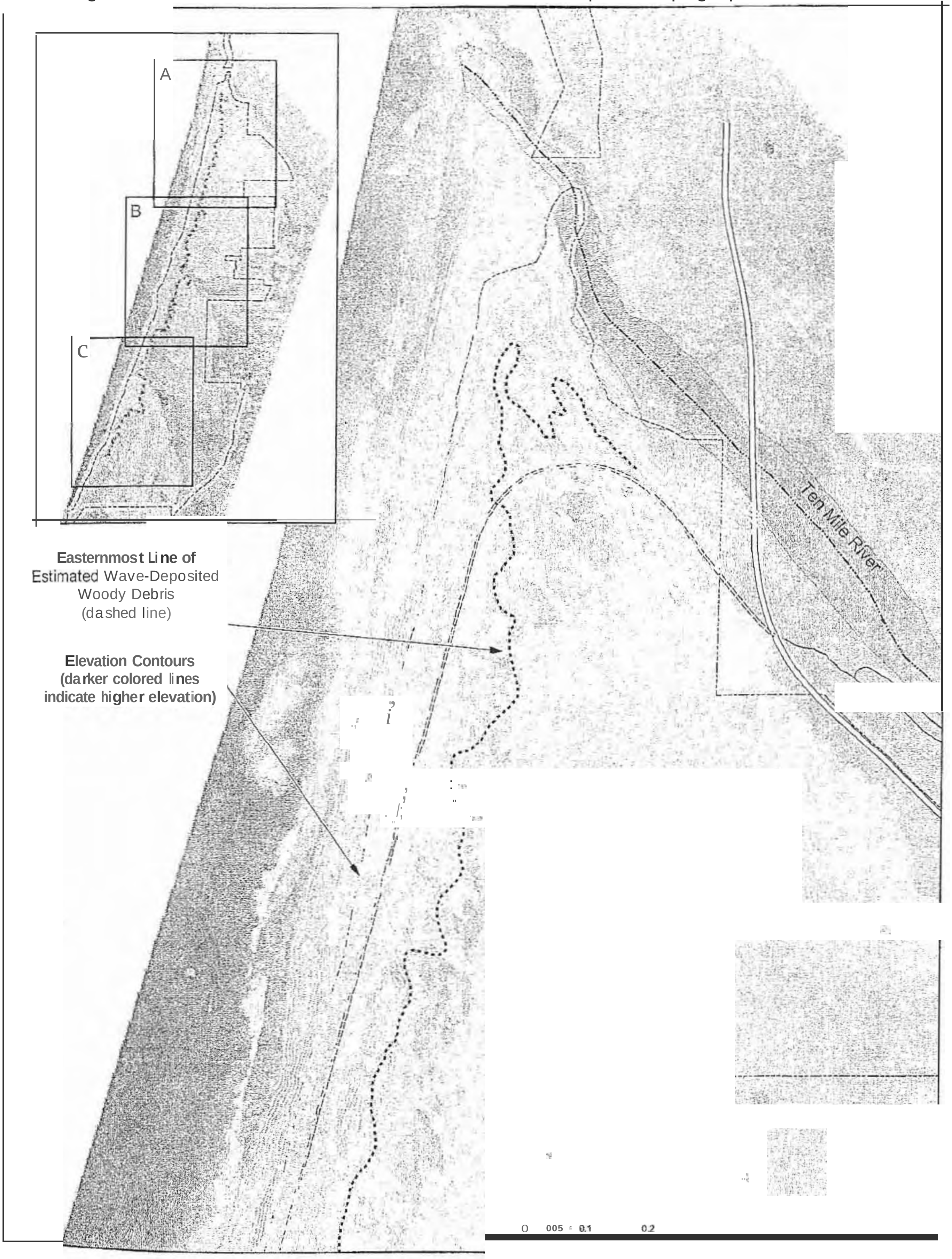
Wave-Deposited Woody Debris Mapping, 2004
Inglenook FenlTen Mile Dunes Natural Preserve



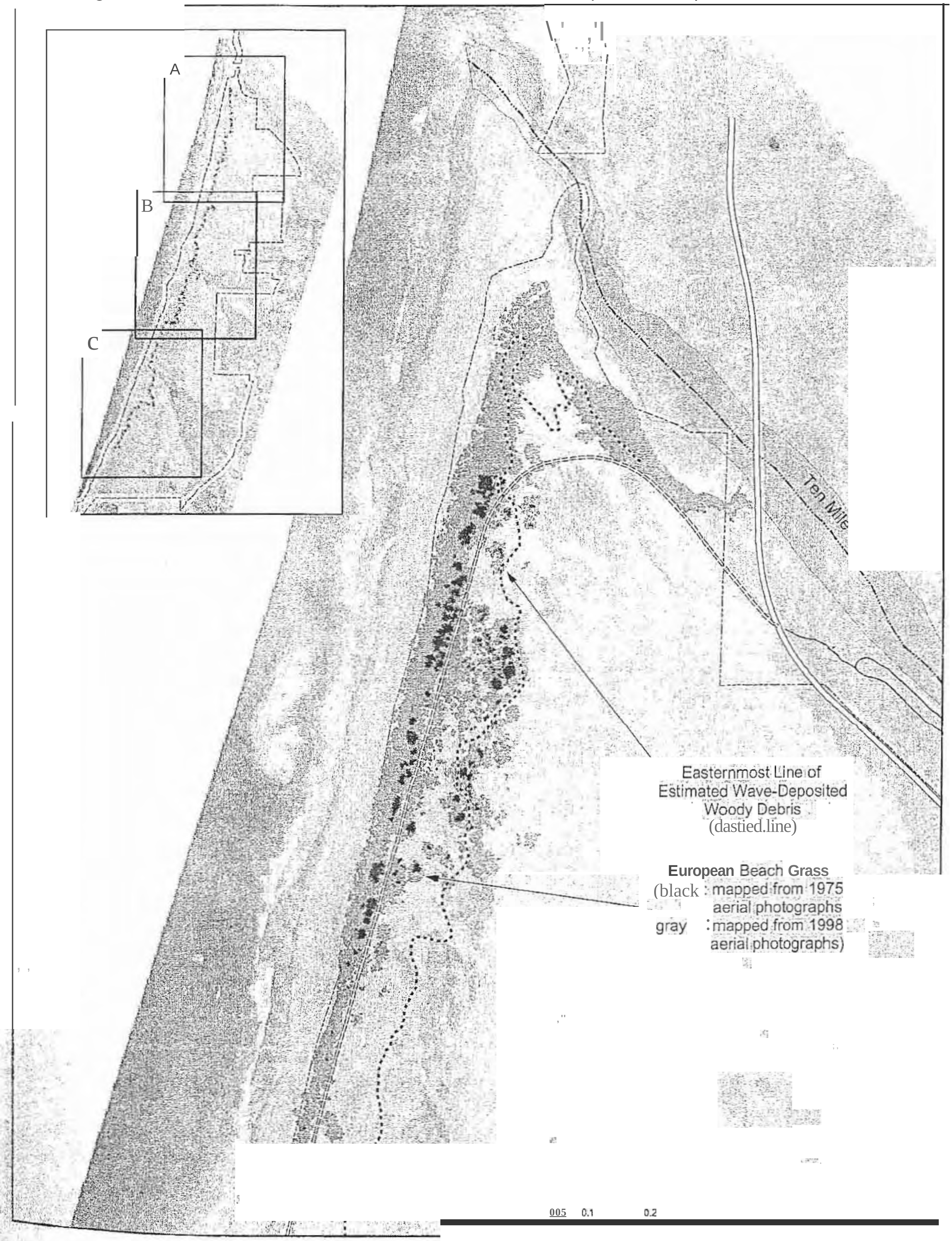
Easternmost Line of Estimated Wave-Deposited Woody Debris (dashed line)

Southern Terminus of Ocean Wave Influence in the Dunes

Wave-Deposited Woody Debris Mapping
Inglenook Fen/Ten Mile Dunes Natural Preserve - Map A1, Topographic Contours

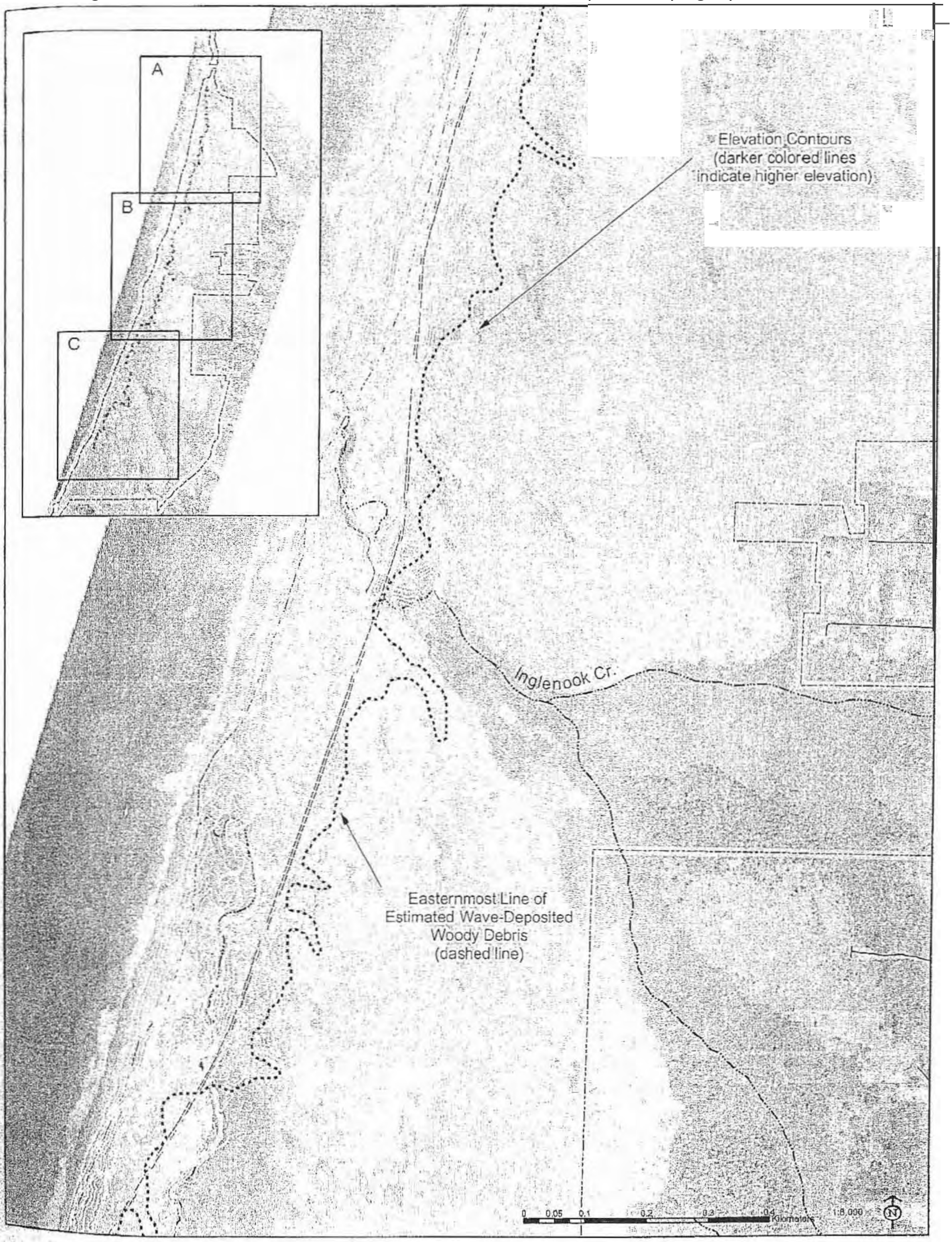


Wave-Deposited Woody Debris Mapping
Inglenook FenlTen Mile Dunes Natural Preserve - Map A2, European Beach Grass



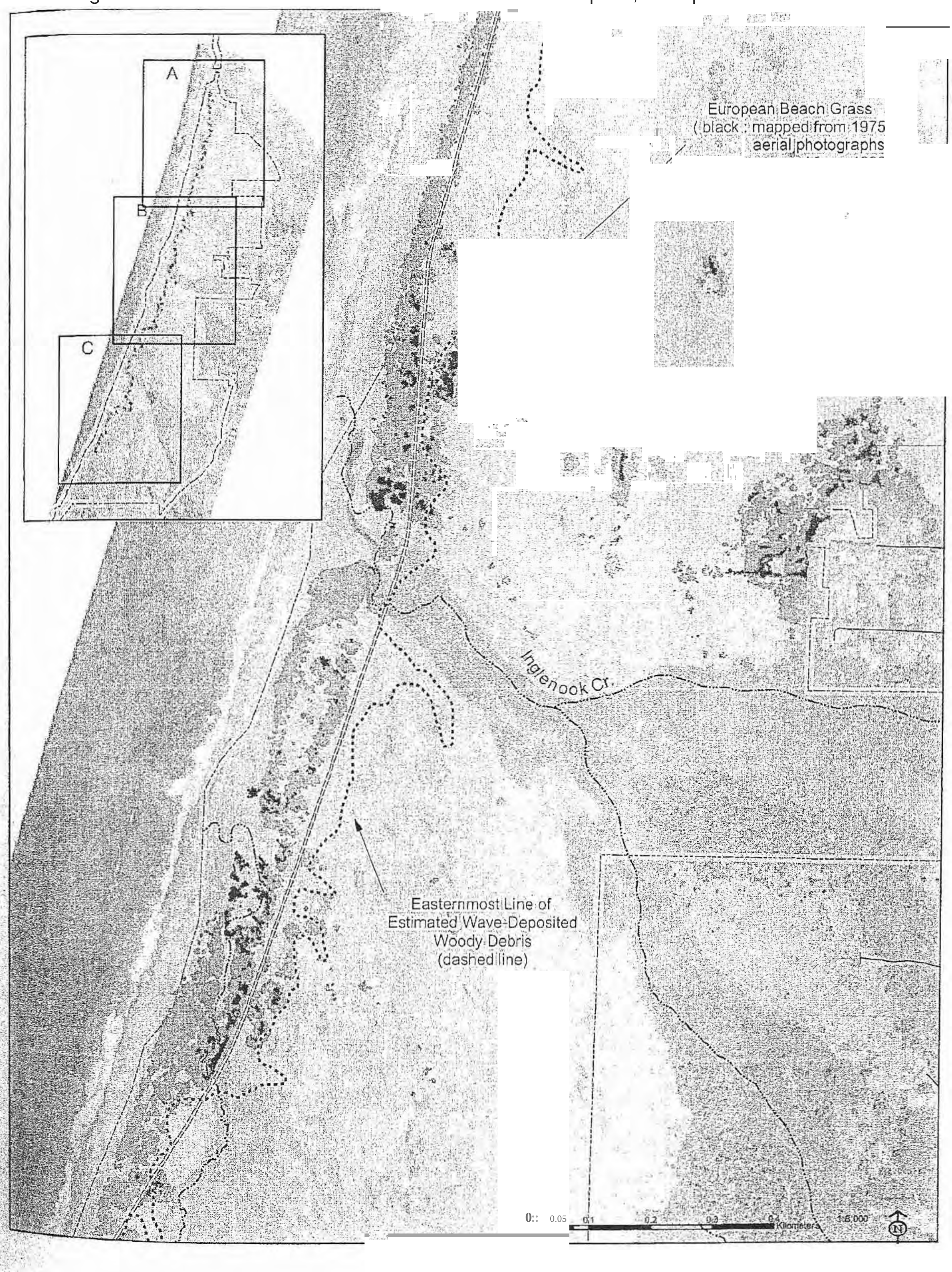
Wave-Deposited Woody Debris Mapping

Inglenook Fen/Ten Mile Dunes Natural Preserve · Map **81,** Topographic Contours



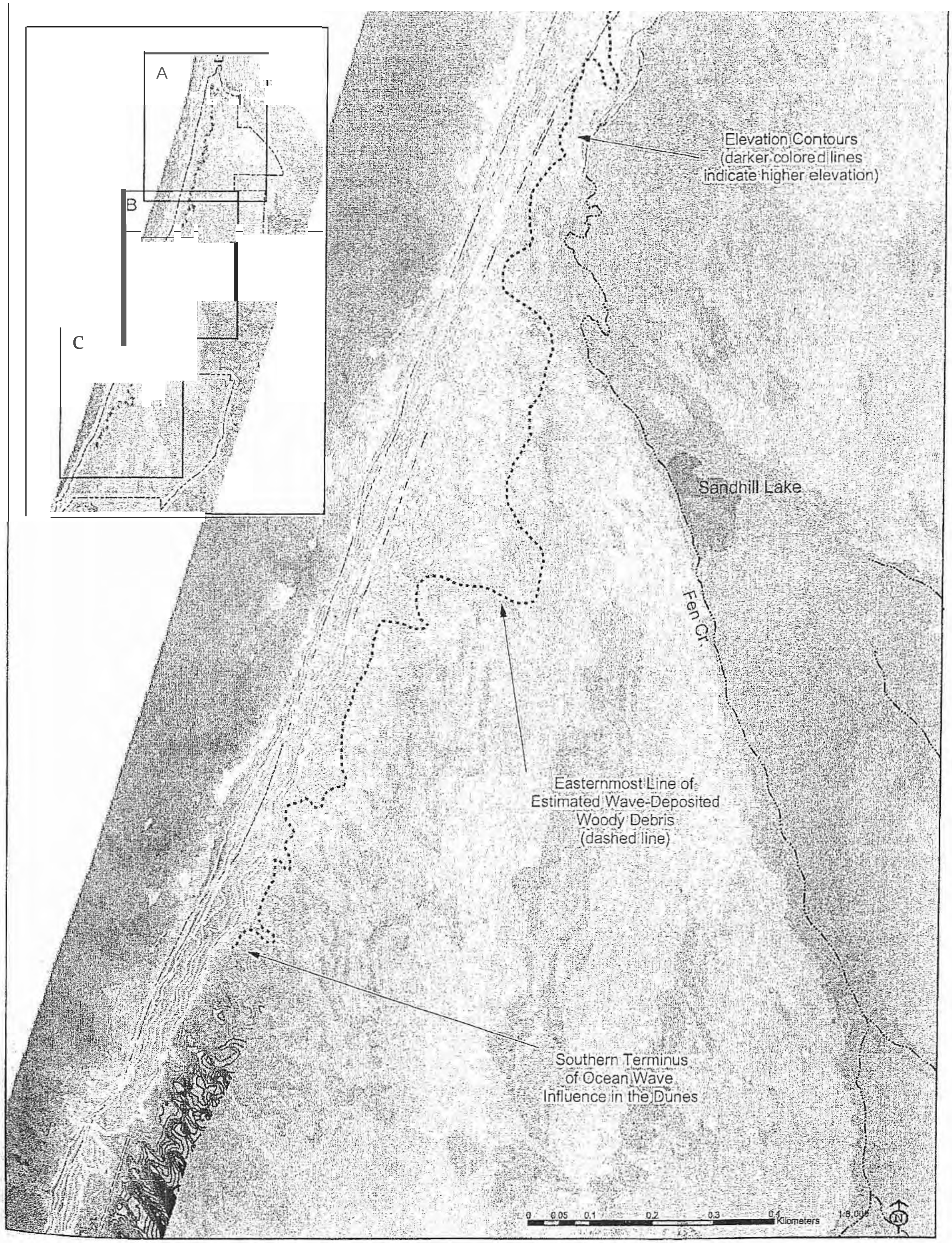
Wave-Deposited Woody Debris Mapping

Inglenook FenlTen Mile Dunes Natural Preserve - Map 82, European Beach Grass



Wave-Deposited Woody Debris Mapping

Inglenook FenlTen Mile Dunes Natural Preserve - Map C1, Topographic Contours



Wave-Deposited Woody Debris Mapping

Inglenook Fen/Ten Mile Dunes Natural Preserve · Map C2, European Beach Grass