HANDBOOK
FOR
LAND USE MONITORING
ORGAN PIPE CACTUS
NATIONAL MONUMENT

CONTRACT CX8000-7-0031

PREPARED FOR:

NATIONAL PARK SERVICE
WESTERN REGION
SAN FRANCISCO, CA

SEPTEMBER 1988

PREPARED BY:

GREAT WESTERN RESEARCH
MESA, ARIZONA

H A N D B O O K

F O R

L A N D U S E M O N I T O R I N G

O R G A N P I P E C A C T U S

N A T I O N A L M O N U M E N T

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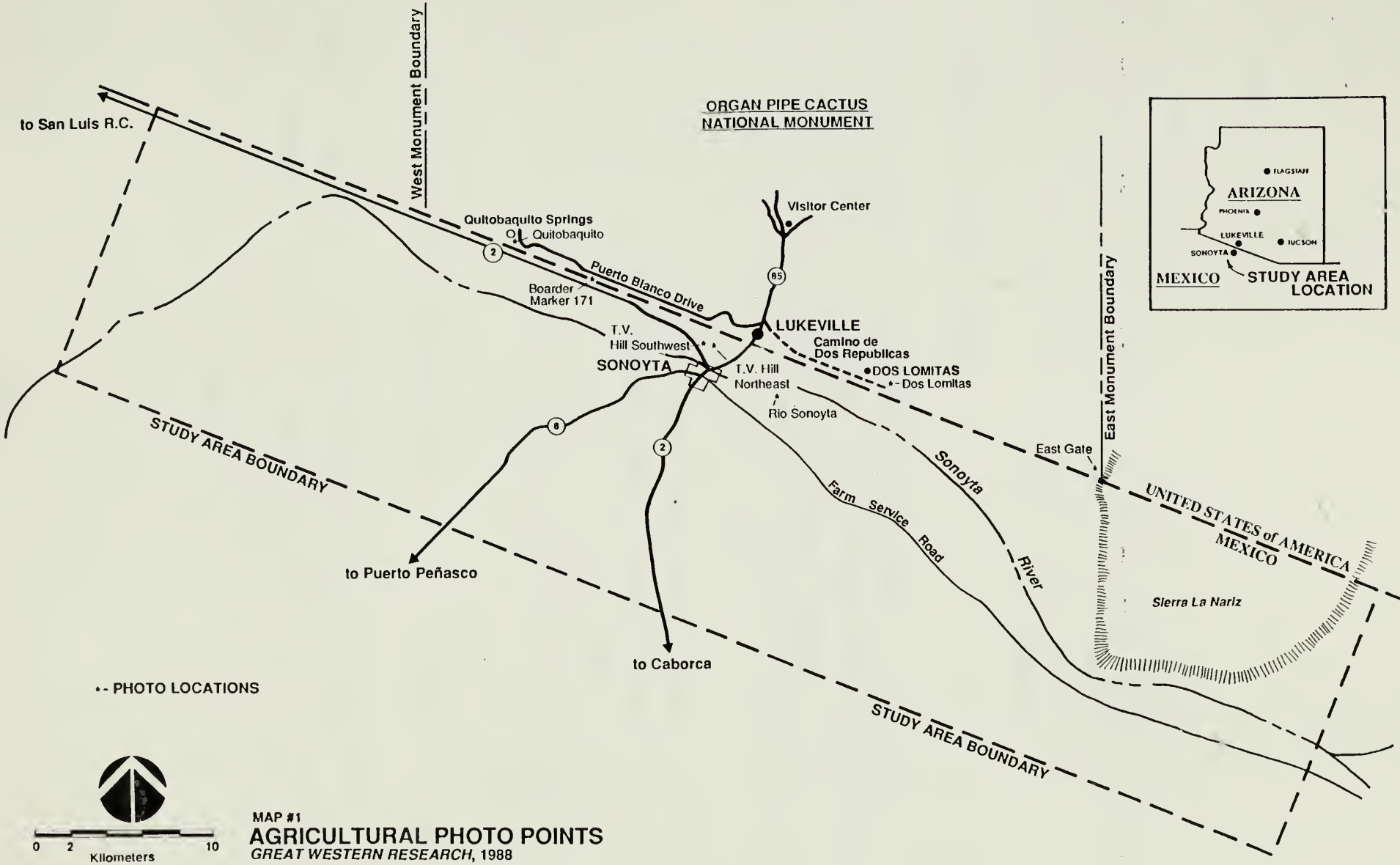
1.0 INTRODUCTION

The purpose of this handbook is to define the protocol for monitoring: (1) agricultural land use in the Sonoyta Valley; and (2) light pollution impacts in the Organ Pipe Cactus National Monument (ORPI). The monitoring activities set forth in this handbook will generate information which will serve to expand the data series initiated by the study entitled: "Land Use Trends Surrounding Organ Pipe Cactus National Monument".

The handbook is divided into two parts, the first part prescribes the protocol for monitoring agricultural land use and the second part sets forth the protocol for monitoring the impacts of light pollution. A major portion of the monitoring activities involve taking photographs from predesignated photo points shown in Map #1. Photographic and other equipment requirements include the following:

-Two (2) 35mm cameras,
-One macro lens having 40 mm capability,
-One tripod,
-Sun shades and green filters for the lens,
-Five (5) rolls of 36 exposure (or equivalent 24 exposure) Black & White 400 ASA film,
-Five (5) rolls of 36 exposure (or equivalent 24 exposure) 64 ASA color slide film,
-Compass,
-2- or 4-Wheel Drive Vehicle,
-Flashlight for Light Pollution Photo Points.



MAP #1

AGRICULTURAL PHOTO POINTS

GREAT WESTERN RESEARCH, 1988

2.0 MONITORING OF AGRICULTURAL LAND USE

The monitoring of agricultural land use in the Sonoyta Valley will be achieved through a series of seven photo points. Photographs from each location will be compared to previous photographs taken from the same location. The results will be interpreted in an attempt to identify emerging trends.

2.1 LOCATION OF PHOTO POINTS

Each photo point is identified with a metal tag attached to a three-foot length of iron rod. The rods have been driven into the ground until only the top 4-6 inches are exposed. The general location map (Map 1) should be consulted by monitors who have not previously been to the photo points.

The suggested route is to follow Puerto Blanco Drive to Quitobaquito Springs and complete Photo Points #1 and #3. Return to Highway 85 and cross the border into Mexico to visit Photo Points #2, #4 and #5. Return to Lukeville and proceed to the Camino de Dos Republicas following this road to Photo Points #6 and #7.

2.1.1 Photo Point #1, Quitobaquito

Photo Point #1 is called Quitobaquito and is located near Quitobaquito Springs. Park your vehicle in the parking lot and proceed northeast following the road along which you came for 1/4 mile. At this point, turn north and hike up a hill to the crest where the tag can be located.

2.1.2 Photo Point #2, T.V. Hill Southwest

Photo Point #2 is located in Mexico on the last portion of the Sonoyta Mountains. A relay station surrounded by a metal fence and several tall antennas are visible on the west side of the main road after crossing into Mexico. This is where the Photo Point is located.

After crossing into Mexico, proceed south from the border approximately 1 mile until coming to an open field with a soccer goal on the west side of the road. Take the small dirt road that runs northwest along the foot of the hill. Follow this road to the second turn towards the hill and turn south. This road will take you up the hill to the relay station. Park your vehicle and follow the path leading to the metal fence. The iron rod and metal tag are located 25 feet north of the gate to the fence on the southwest corner.

2.1.3 Photo Point #3, Border Marker 171

Photo Point #3 is just south of Puerto Blanco Drive about 10 miles west of the intersection with Highway 85. At this point, there is a group of hills which extend to the border and into Mexico. The photo point is located on the highest rise directly south of the road and is best approached from the western side.

2.1.4 Photo Point #4, T.V. Hill Northeast

Photo Point #4 is located on the northeast corner of the same relay station near Photo Point #2. Proceed from Photo Point #2 along the fence around the south side. The iron rod and tag are located on the northeast corner of the enclosure.

2.1.5 Photo Point #5, Rio Sonoyta

Photo Point #5 is located in Mexico. Proceed from the border south to the intersection with Camino 2. Take Camino 2 south to the main plaza where this road intersects Camino 8 leading to Puerto Peñasco. Continue south on Camino 2 for 1/4 mile and turn east onto a paved road leading out of town. Follow this road for 2.8 miles.

At this point, the road comes to the top of a small hill. Upon reaching the top of the hill, turn left onto a dirt road which heads north for approximately 250 feet where it divides. Take the left fork and proceed 0.6 miles to a vacant field where the road forks again. Take the left road for 0.4 miles and park vehicle in an open area along the river bank. Proceed south hiking to the top of a medium sized hill. The photo point is located on the crest of this hill.

2.1.6 Photo Point #6, Dos Lomitas

Photo Point #6 is located along the Camino de Dos Republicas east of Lukeville. Proceed along the road for 3.7 miles where two small hills can be seen to the northeast. Park your vehicle on the side of the road and hike across a flat fan area towards the hill lying fartherest to the east. Proceed to top of the hill where the photo point is located.

2.1.7 Photo Point #7, East Gate

Photo Point #7 is located in the extreme southeastern point of ORPI. Proceed along the Camino de Dos Republicas to where it terminates at the foot of the Sierra de Santa Rosa Mountains. Follow the barbed wire fence up the hill. The photo point is located about 20 feet west of where the fence terminates and the tag can be found anchored to a rock.

2.2 PHOTOGRAPHIC DOCUMENTATION

It is recommended that photographic documentation be collected two times during the year, during the months of March and September, always on a near cloudless day.

Photographic documentation will be the same for all photo points. The procedure is to take pictures from each point which results in a 360° panorama of the surrounding landscape.

Erect the tripod over (or as near as possible) each photo point marker and mount the camera containing black & white film to the tripod. Make sure that the sun shade and green filter are in place and set the macro lens to **40 mm**. Using the compass, find the North cardinal point. Position the camera to 45° and take the first picture.

Record this event on Monitoring Form #1 under the section for black & white film. An "x" goes in the blank opposite the 45° number to signify that a picture has been taken from this angle. Fill in the information regarding picture number on the roll of film in the camera, filter type, exposure speed and F-stop. It is recommended that, for cameras with automatic settings, the initial exposure speed be set at 250 and let the camera automatically determine the appropriate F-stop.

Immediately following the first picture, change the exposure speed to 125 and take another picture. Record the information for the second picture in the spaces provided to the right of the data from the first picture.

Once two pictures have been taken from the 45° angle, shift the camera to the 90° angle. Repeat the process of taking two pictures and shift the camera another 45 degrees.

Repeat this process until a total of 16 pictures have been taken, two at each of the eight angles spaced 45 degrees apart.

Remove the camera with the black & white film and mount the camera with color slide film. Position the camera at the 45° angle and repeat the picture taking procedure described above for all angles filling in the lower portion of Monitoring Form #1 during the process. A check list is included at the bottom of the form which summarizes the picture documentation procedure in nine sequential steps.

3.0 MONITORING LIGHT POLLUTION

Monitoring light pollution impacts consists of the periodic photographic documentation and calculation of light pollution intensity. Photographic documentation is to be conducted from two photo points. Interpretation of the resulting photographs will serve to cross-check separate calculations of light pollution intensity.

3.1 LOCATION OF PHOTO POINTS

Two photo points have been established to monitor light pollution impacts in ORPI. These photo points are identified in the same manner as the agricultural photo points, with metal tags and iron rods driven into the ground. Main roads lead to the general location of both photo points where the exact location can be reached after a short hike.

3.1.1 Light Pollution Photo Point #1

Photo Point #1 is located just north of the border on the western slope of where the Puerto Blanco Drive intersects the Sonoyta Mountains. From Highway 85, follow Puerto Blanco Drive

for exactly 2.0 miles and park the vehicle at the side of the road. Proceed south and climb the steep hill encountered immediately after leaving the road. Following the ridge a short distance towards the southwest will lead to the tag and iron rod wedged in a small outcropping of rock. This vantage point commands a view of the Town of Sonoyta and the western section of the valley including Camino 2.

3.1.2 Light Pollution Photo Point #2

Photo Point #2 is located south of the Visitor Center on the road to the main campground. Proceed 0.5 miles from the turnoff leading to the main campground. Park the vehicle on the south side of the road in a pullout near the wash and locate a large saguaro cactus on the peak of the hill immediately to the west. Hike to the saguaro. From the base of the saguaro, proceed along the ridge in a westerly direction for approximately 45 paces. The metal tag and iron rod are located in a small, flat clearing near a small outcrop of rock.

This photo point commands a view of Lukeville and the valley to the east. The Town of Sonoyta is almost entirely shielded by the Sonoyta Mountains. Since a large share of night-time viewing in ORPI occurs from this general area, this point has been selected as representative of the night-time viewscape encountered by many observers.

3.2 PHOTOGRAPHIC DOCUMENTATION

It is recommended that photographs monitoring light pollution be taken once a year in the month of November. The same procedure used in documenting agricultural land use will be used to monitor light pollution impacts with the following two exceptions. The first exception is that the photographs are to be taken on a clear moonless night after 9:00 pm.

The second exception deals with the exposure of the photographs. Since the cameras will be set on "bulb", the length of exposure must be timed. The first photograph will have a 10 second exposure and the second photograph will have a 20 second exposure. A total of eight black & white pictures will be taken with a 10 second exposure and eight with a 20 second exposure. The same is also true for the taking of color slides.

Photographic documentation will be the same for all photo points. The procedure is to take pictures from each point which results in a 360° panorama of the surrounding viewscape.

Erect the tripod over (or as near as possible) each photo point marker and mount the camera with black & white film to the tripod. No sun shade or filter are required. Using the compass, find the North cardinal point. Position the camera to 45° from this point, set the macro lens to **40 mm** and take the first picture.

Record this event on Monitoring Form #2 under the section for black & white film. An "x" goes in the blank opposite the 45° number to signify that a picture has been taken from this angle. Fill in the information regarding picture number on the roll of film in the camera and exposure time in seconds.

Immediately following the first picture, change the exposure time to 20 seconds and take another picture. Record the information for the second picture in the spaces provided to the right of the data entries for the first picture.

Once two pictures have been taken from the 45° angle, shift the camera to the 90° angle. Repeat the process of taking two pictures and then shifting the camera 45 degrees for

another two pictures. Repeat this process until a total of 16 pictures have been taken, two at each of the eight angles spaced 45 degrees apart.

Remove the camera with the black & white film and mount the camera with color slide film. Position the camera at the 45° angle and repeat the picture taking procedure described above for all angles filling in the lower portion of Monitoring Form #2 during the process. A check list is included at the bottom of the form which summarizes the picture documentation procedure in nine sequential steps.

3.3 INTERPRETATION

Array the photographs in plastic holders and compare them to the photographs taken in the previous year. It will only be possible to determine if light pollution is more visible, less visible or the same as observed in the previous year. Under present conditions, observable light pollution is only encountered in the 180° and 225° angles at Photo Point #1 and in the 135° and 180° angles at Photo Point #2. Nevertheless, it is important to maintain a good vigilance of the other angles in the event that observable light pollution does develop in the future.

Results from the interpretation of the resulting photographs will be used to support the calculations described in the next section.

3.4 MEASURING LIGHT POLLUTION IMPACTS

Measurements of light pollution impacts will be made in relative terms compared to natural "black sky" conditions using the following formula:

$$I = (0.01Pr^{-2.5})E$$

where I is the change in the sky glow level as compared to a dark sky natural background, P is population of the area under observation, r is the distance in kilometers from the point of observation to the source of light pollution, and E is the per capita consumption of electricity in kilowatt hours.

In order to calculate this formula, it is necessary to collect data related to the population and electrical consumption. The value of r is already defined for each photo point. In Photo Point #1, the value of r is 4.0 kilometers for the angle of 180° and 8.0 kilometers for the angle of 225°. In Photo Point #2, r is equal to 6 kilometers for the 180° angle and 14 kilometers for the 135° angle.

Population data can be obtained from the mayor's office in Sonoyta or from the Municipality offices in Puerto Peñasco. The population at the end of 1987 for the Town of Sonoyta was estimated to be 15,000 people.

Electrical consumption data can be collected from the Comisiòn Federal de Electricidad in Sonoyta or in Puerto Peñasco. These data are recorded separately for irrigation and domestic uses. Energy consumption for domestic use is to be divided by the population to estimate the E variable in the formula. In the event that electrical data are not conveniently available in domestic and non-domestic consumption, an alternative method is to take the total amount consumed in the month of November. During this month, most of the irrigation wells are shut down for the annual well inventory and, consequently, electrical consumption is almost entirely representative of domestic use.

The value of E to be used in the equation is 14.711. This value should be used until updated information indicate that the average daily per capita use of electricity is different.

Once these data are collected, calculate the new values for the two photographic angles of 180° and 225° in Photo Point #1. The 1987 values were 68.96 and 0.1625, respectively.

The results are to be plotted on Figures 1 and 2 where the baseline conditions have already been recorded. A separate computer file called LIGHTGRAPH has been established into which the computed values for each angle can be entered to update the graphs. This file uses LOTUS to perform these functions.

Next, proceed to calculating the values for Photo Point #2. Again, only two angles, 180° and 135°, are presently under consideration. The distance for angle 180° is 6 kilometers and 14 kilometers for angle 135°. Population estimates will be required for the Town of Lukeville and the rural area to the southwest. The same energy consumption per capita value used in the calculations for Photo Point #1 is to be used for Photo Point #2. The 1987 value for the 180° angle is 26.692 and 0.2006 for the 135° angle. The results are to be plotted in Figures 3 and 4.

Upon completion of all calculations, print the updated graphs for Figures 1, 2, 3, and 4, and add this information to the existing data file.

MONITORING FORM #1

PHOTO POINT _____ DATE: _____

BLACK & WHITE:

FILM _____ ASA _____

	45°		90°		135°		180°	
Number	____	____	____	____	____	____	____	____
Filter	____	____	____	____	____	____	____	____
Exposure	____	____	____	____	____	____	____	____
F-Stop	____	____	____	____	____	____	____	____

	225°		270°		315°		360°	
Number	____	____	____	____	____	____	____	____
Filter	____	____	____	____	____	____	____	____
Exposure	____	____	____	____	____	____	____	____
F-Stop	____	____	____	____	____	____	____	____

COLOR SLIDES:

FILM _____ ASA _____

	45°		90°		135°		180°	
Number	____	____	____	____	____	____	____	____
Filter	____	____	____	____	____	____	____	____
Exposure	____	____	____	____	____	____	____	____
F-Stop	____	____	____	____	____	____	____	____

	225°		270°		315°		360°	
Number	____	____	____	____	____	____	____	____
Filter	____	____	____	____	____	____	____	____
Exposure	____	____	____	____	____	____	____	____
F-Stop	____	____	____	____	____	____	____	____

CHECK LIST:

___ Document photo point name.
___ Record date.
___ Setup tripod.
___ Record film type and ASA.
___ Mount camera with <u>black & white</u> film.
___ Take pictures and record on form.
___ Mount camera with <u>color slide</u> film.
___ Take pictures and record on form.
___ Sign form.

MONITOR _____

MONITORING FORM #2

PHOTO POINT _____ DATE: _____

BLACK & WHITE:

FILM _____ ASA _____

	45°		90°		135°		180°	
Number	____	____	____	____	____	____	____	____
Exposure	____	____	____	____	____	____	____	____

	225°		270°		315°		360°	
Number	____	____	____	____	____	____	____	____
Exposure	____	____	____	____	____	____	____	____

COLOR SLIDES:

FILM _____ ASA _____

	45°		90°		135°		180°	
Number	____	____	____	____	____	____	____	____
Exposure	____	____	____	____	____	____	____	____

	225°		270°		315°		360°	
Number	____	____	____	____	____	____	____	____
Exposure	____	____	____	____	____	____	____	____

CHECK LIST:

___ Document photo point name.
___ Record date.
___ Setup tripod.
___ Record film type and ASA.
___ Mount camera with <u>black & white</u> film.
___ Take pictures and record on form (10 second and 20 second exposures).
___ Mount camera with <u>color slide</u> film.
___ Take pictures and record on form (10 second and 20 second exposures).
___ Sign form.

MONITOR _____

FIGURE 1: 180 DEGREE ANGLE

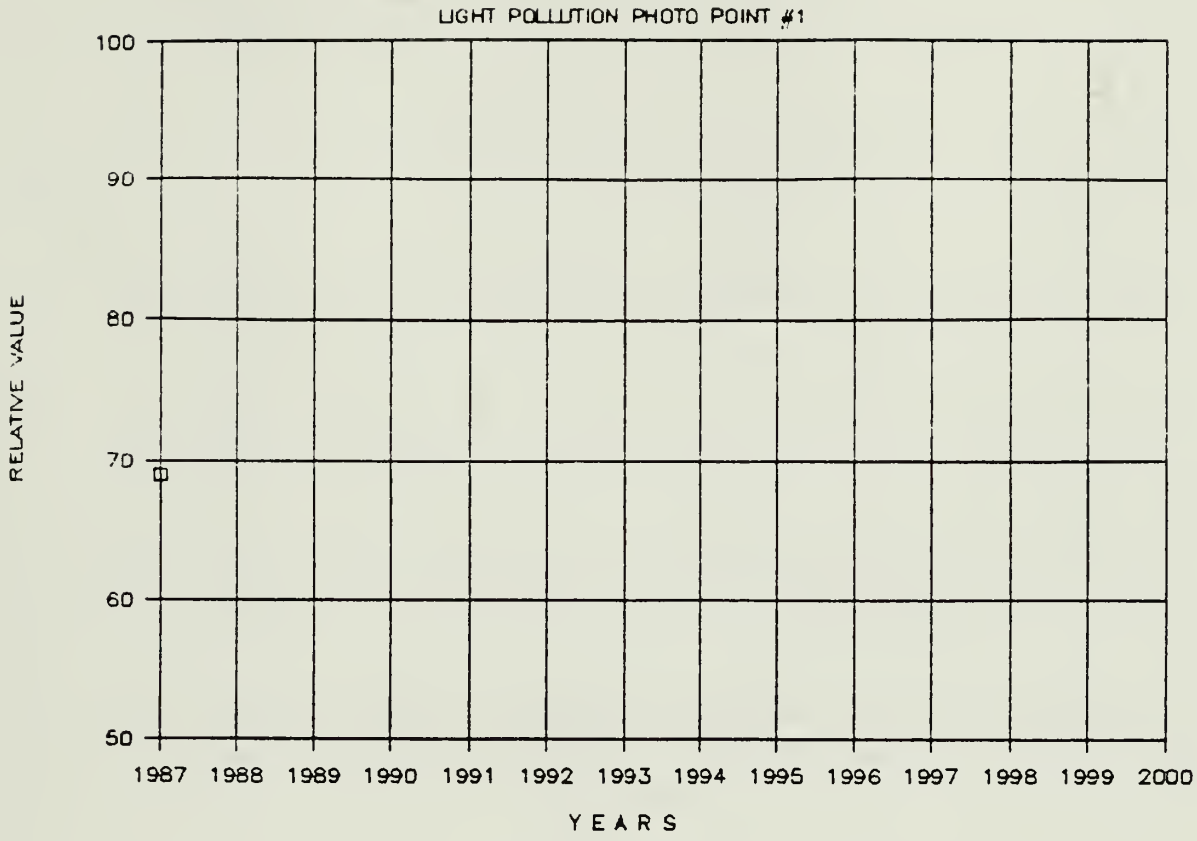


FIGURE 2: 225 DEGREE ANGLE

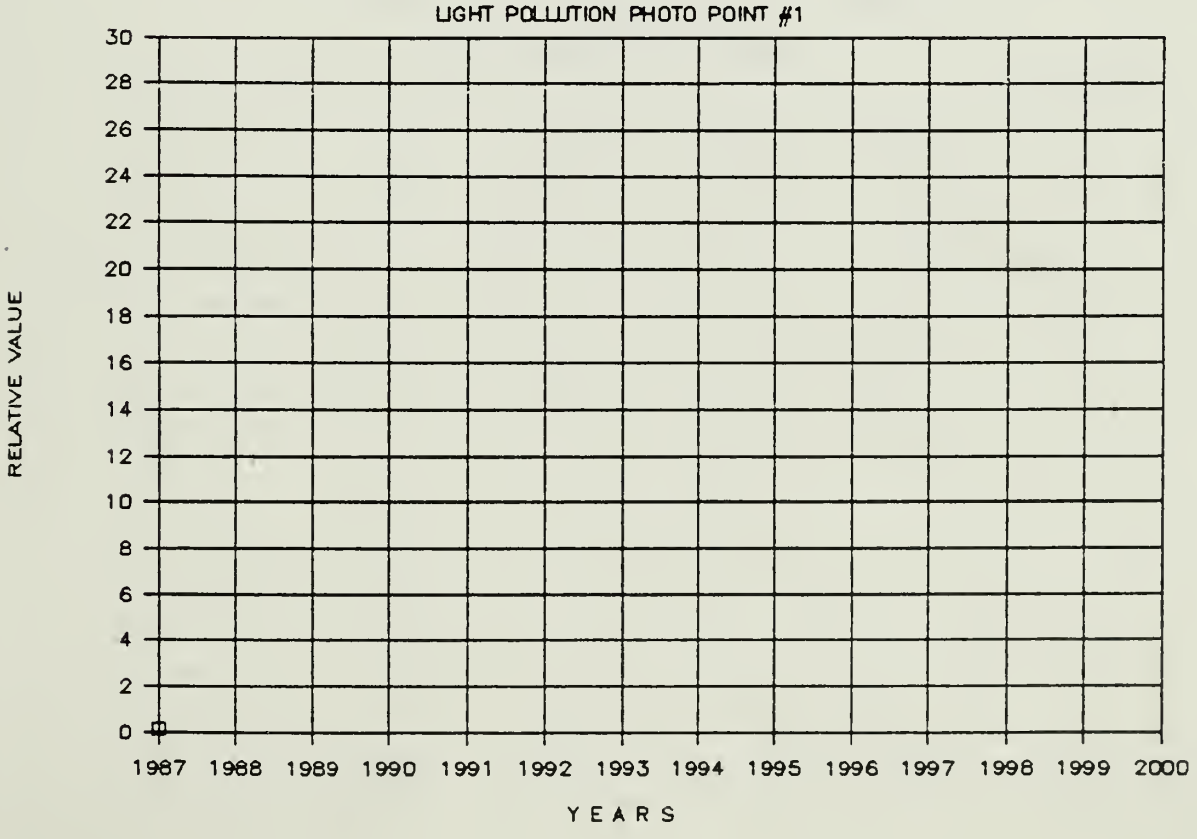


FIGURE 3: 180 DEGREE ANGLE

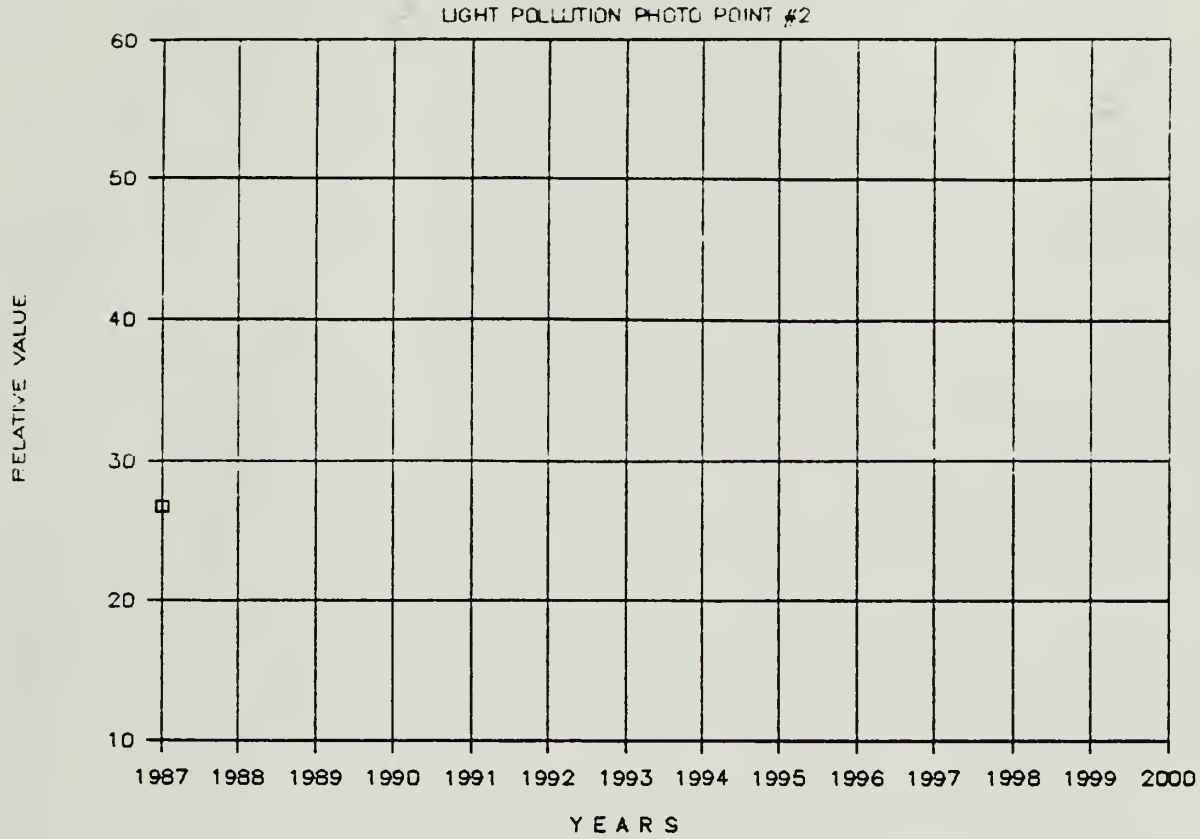


FIGURE 4: 135 DEGREE ANGLE