United States
Department
of Agriculture

Forest Service

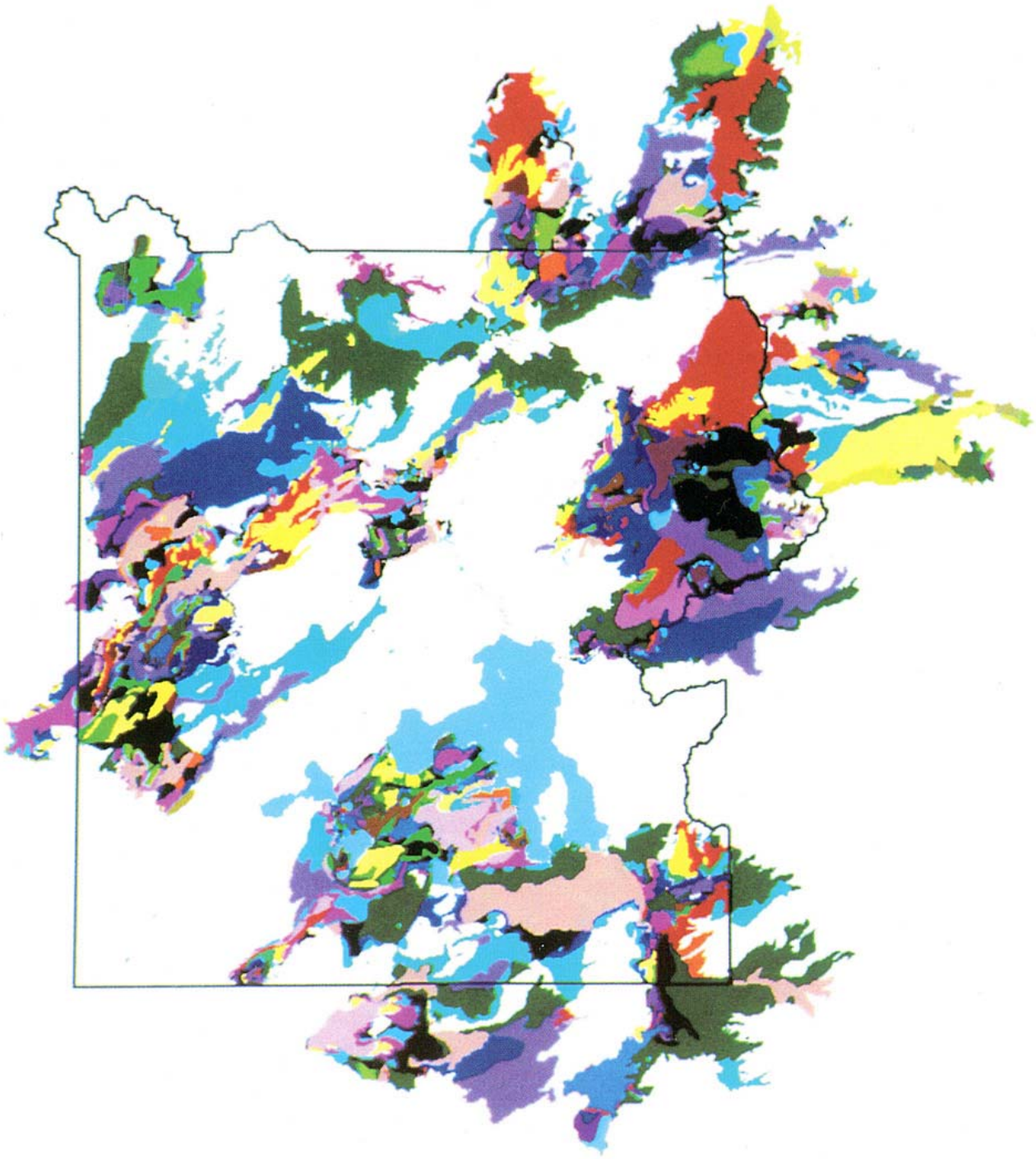
**Intermountain
Research Station**

General Technical
Report INT-304

January 1994

Fire Growth Maps for the 1988 Greater Yellowstone Area Fires

Richard C. Rothermel
Roberta A. Hartford
Carolyn H. Chase



THE AUTHORS

RICHARD C. ROTHERMEL is a senior scientist at the Intermountain Fire Sciences Laboratory in Missoula, MT. He served 26 years as Project Leader of the Fire Behavior Research Work Unit there. Rothermel has degrees from the University of Washington (B.S. aeronautical engineering, 1953) and Colorado State University (M.S. mechanical engineering, 1971). He has published and lectured extensively both in the United States and abroad. His most notable contribution has been the development of a fire spread model that has been used as the basis for the National Fire Danger Rating System and several other systems that require an estimate of fire behavior. Rothermel is working with scientists in Australia and Canada to develop models for the next generation of fire behavior and fire danger systems.

ROBERTA A. HARTFORD is a forester at the Intermountain Fire Sciences Laboratory in Missoula, MT. She began working at the Fire Lab in 1968, assisting with studies on the chemical and physical properties of fuels. During the early 1970's she also worked seasonally in fuel inventory and taught high school science. Since 1976 she has remained at the Fire Lab where she has been involved in studies of fuels and fuel bed properties, smoldering combustion, and fire behavior of both laboratory and wildland fires. Recent work includes studies in the use of satellite remote sensing to assess fire potential in wildland vegetation and the use of geographic information systems to document wildfire growth. She has a B.A. degree in zoology from the University of Montana in Missoula and an M.S. degree in forestry there.

CAROLYN H. CHASE is a mathematician stationed at the Intermountain Fire Sciences Laboratory. She received her B.A. degree in mathematics from the University of Montana in 1969. Chase began working at the Fire Lab in 1978; she is a member of the systems development and application team. Her current work includes integration of geographic information system technology for the next generation of fire danger and fire behavior prediction systems.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the valuable assistance of many individuals in the following organizations. Without their support this comprehensive project would not have been possible.

The Denver office of the National Park Service, for its assistance in installing hardware and software, GRASS and UNIX training, preparing data tapes compatible with our computer system, and continued support in problem resolution.

The Boise office of the National Park Service, for lending its work station to start the project before purchase of our machine.

Yellowstone National Park, for lending the wall map assembled at park headquarters in Mammoth during the summer of 1988, preparing additional data for transfer to our system, helping locate missing data, and accepting the responsibility to distribute the electronic data.

Andy Norman from the Bridger-Teton National Forest for interpreting fire growth on the Huck and Mink Fires and providing maps of those fires.

The U.S. Department of Agriculture and U.S. Department of the Interior for partially funding this work from the grant for Greater Yellowstone Area postfire response studies.

The GIS Laboratory at Central Washington University, Ellensburg, for digitizing the initial data from the headquarters wall map.

RESEARCH SUMMARY

The growth of the 1988 fires in the Greater Yellowstone Area from June 14 to October 1 has been digitized and displayed in the form of daily fire growth maps. A geographic information system (GIS) was used to process the data for distribution and analysis. The fire record integrates information and data from a variety of sources, including daily infrared photography flights, satellite imagery, ground and aerial reconnaissance, command center intelligence, and the personal recollections of fire behavior observers. Using GRASS GIS software, fire position was digitized from topographic maps to construct a file of daily fire location in vector format. The vector file was converted to raster format for further analysis. The data base is available in electronic form. A summary of the growth of the fire and points of interest throughout the summer is included.

Cover: The cover shows the daily growth of the 1988 Yellowstone Fires. Each color represents one day's growth.

Intermountain Research Station
324 25th Street
Ogden, UT 84401

Fire Growth Maps for the 1988 Greater Yellowstone Area Fires

Richard C. Rothermel
Roberta A. Hartford
Carolyn H. Chase

INTRODUCTION

In the summer of 1988, Yellowstone National Park and adjoining areas within the National Forests, commonly referred to as the Greater Yellowstone Area (fig. 1), experienced the most extensive forest fires seen in the Western States since the great Northwest fires of 1910. As the summer progressed and the fires continued to spread unabated, it became apparent that unprecedented opportunities for studying large-fire behavior were at hand. However, the very size, intensity, and remoteness of the fires, as well as widespread smoke, made personal observation and mapping all but impossible. Fortunately, there was a strong effort to map fire progress for use in strategic and tactical fire planning.

National Parks and National Forests forming the Greater Yellowstone Area include Yellowstone National Park, Grand Teton National Park, and portions of the Custer, Targhee, Bridger-Teton, Gallatin, Beaverhead, and Shoshone National Forests. Major fires included in the data set are the North Fork-Wolf Lake, Fan, Hellroaring, Storm Creek, Clover-Mist, Huck, Mink and the Snake Complex, consisting of the Falls, Red, and Shoshone Fires.

A research effort was initiated soon after the fires were over to reconstruct the fire behavior and the conditions that produced 3 months of large-fire growth. The purpose was to put together a data set suitable for analyzing large-fire growth. Of particular importance to further study are growth progression, rates of spread, and relation of fire progress to weather and terrain.

The GRASS (U.S. Army Construction Engineering Research Laboratory 1988) geographic information system (GIS) software was used to store and organize the data. The growth layer produced by the GIS contains polygons made up of perimeters representing the fire position, each with the single attribute of date. A complete set of fire growth maps is shown in appendix A. Those maps show the daily fire growth summarized by week. Each color indicates a different day's growth. Fire growth previous to the current week is shown in black; lakes and streams are blue; roads are brown. Daily colors grade from "cool" early in the week, through "warm," with red indicating growth on the last day of the week. These data are available in electronic format. Appendix B describes how to obtain the data set and gives details about file contents, formats, and sizes.

One of the key elements of this work has been a comprehensive effort to resolve conflicting or incomplete data and to develop maps accurately depicting the growth of the fires. Considerable thought and care were given to preparation of the fire growth map, but there are many potential sources of error; the data should not be considered to be the absolute truth. Boundaries, streams, and sites used for reference at map production scales were taken from a variety of sources and were digitized at a variety of scales. These results should not be considered for determining legal questions such as whether or when a fire burned a particular feature. If readers have additional data or corrections they feel should be included in the data set, contact the authors with the details. All suggested additions or corrections will be evaluated early in 1995 and published if warranted.

MAP PREPARATION

The initial data were taken from a large wall map assembled from Department of the Interior, U.S. Geological Survey quadrangle maps (quads) at Yellowstone National Park Headquarters at Mammoth. The location of the fires was recorded on this map, to the extent possible, each day throughout the summer. Figure 2 shows quad coverage over the fire area. The data were obtained primarily from aircraft using infrared (IR) scanners. Two aircraft were available until late August, when one was sent to other fires. Unfortunately, the largest fire growth was taking place at this time, and one aircraft could not cover all of the active fire perimeter in one night of flying. Areas on the Snake Complex in the south, the Clover-Mist Fire in the eastern section, and the North Fork-Wolf Lake Fire were not well mapped late in the summer.

The majority of daily fire positions on the headquarters map could be verified with IR overlays or with chronology information (USDA/USDI 1988). Daily fire growth prior to centralized mapping (and between IR flights) was reconstructed with the help

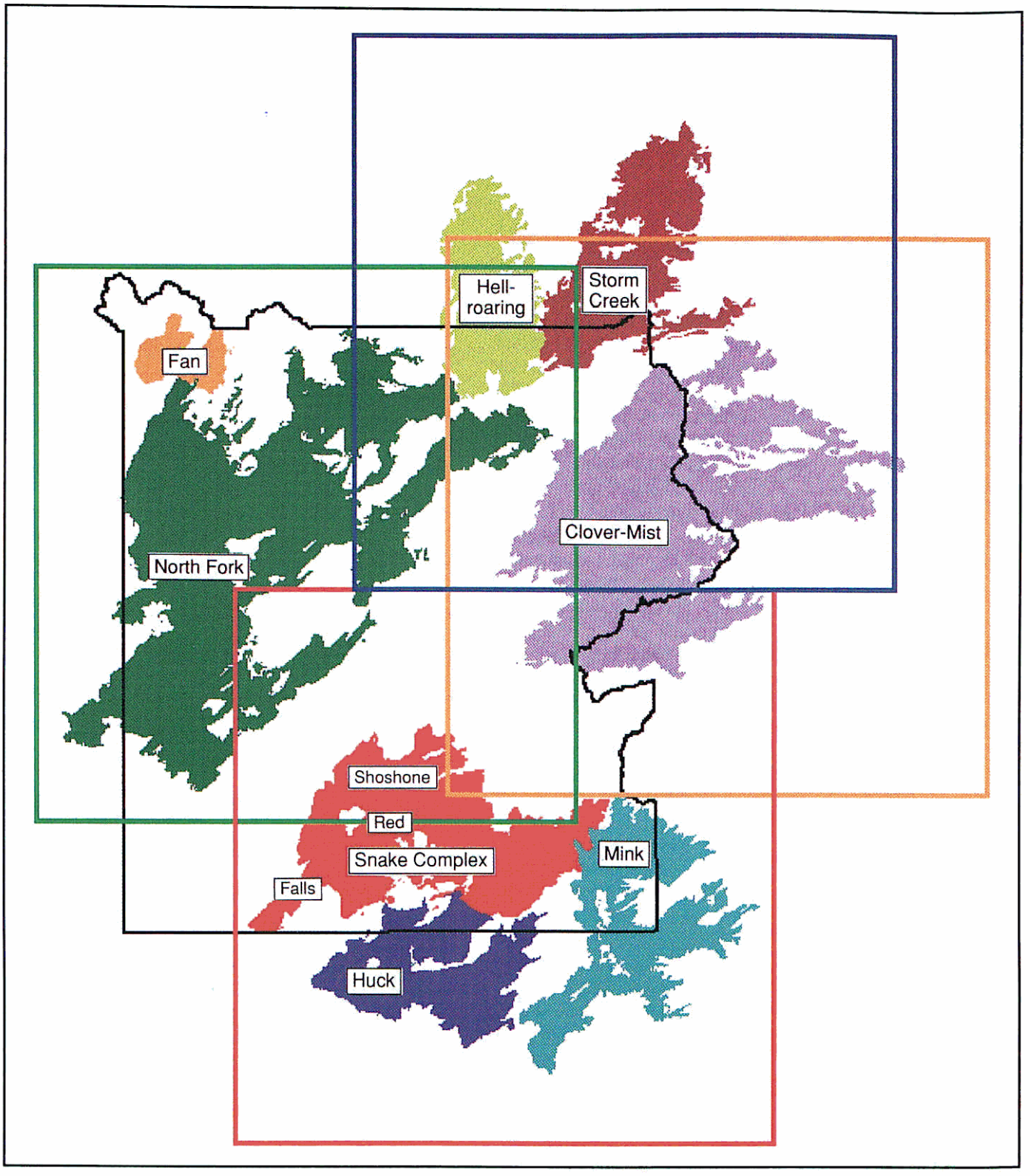


Figure 1—This figure shows the final perimeters of the 1988 fires in the Greater Yellowstone Area. The colored boxes indicate areas covered by the maps in appendix A. Yellowstone National Park is outlined in black.

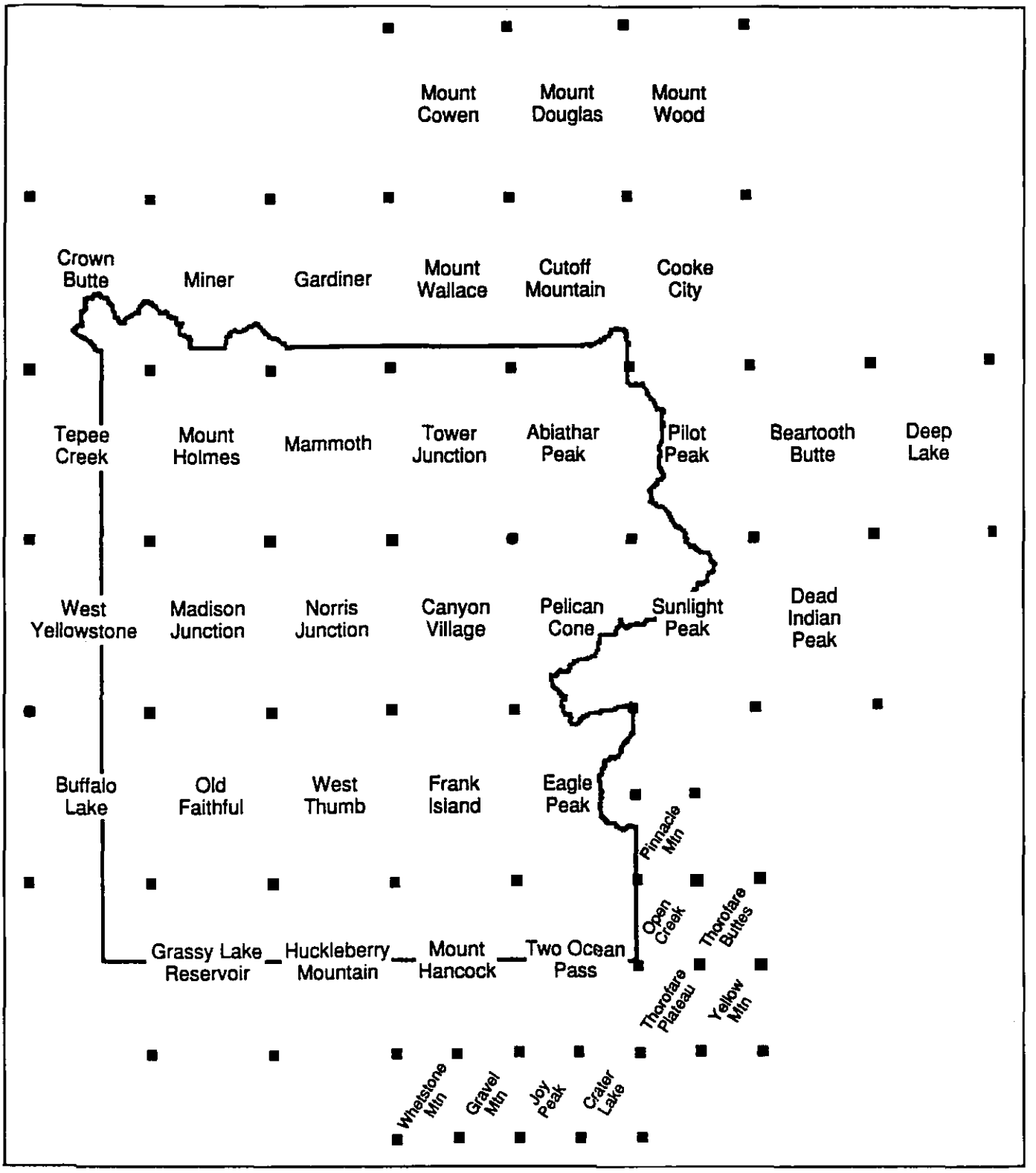


Figure 2—Names and locations of U.S. Geological Survey quadrangle (quad) maps that cover the area described in this report. Quad corners are marked, with quad names inside the area covered by the map.

of maps from the archives at Mammoth and with additional documentation from the files of individual fire teams. In some cases, two or more versions of the daily fire position were found on maps from different sources. Chronology, weather reports, and the teams' shift plan notes were used to select the most probable fire location. Infrared imaging flights were often made after midnight; the dates for some polygons had originally been set by the date of the IR flight instead of the burn-period date. Infrared flight map times and dates and some IR flight log information were used to verify or correct dates of fire growth. Through these efforts, most map dates could be verified by one or more sources of information. In areas flown and mapped daily, the headquarters map perimeters and dates were corrected with a high degree of certainty.

Some of the fire locations in the interior of the fire were uncertain due to large-scale fire activity and the lack of time and resources to map all perimeters. In these cases, we used our experience in fire behavior along with weather records and topography to identify probable dates and perimeter locations. When an area was not observed for several days, a "best-guess" date was assigned based on written descriptions or interviews with fire behavior specialists assigned to the fires. When neither of these methods could be used, the areas were dated as "burned by" the date the perimeter was finally flown.

The fires rarely stopped moving at the end of a day, and the time of the depicted fire growth snapshot was not the same for every 24-hour period. Consequently, fires that made a continuous run past midnight are shown as spreading on two separate days. This is especially noticeable from late August until September 10.

Table 1 shows burned areas by fire and by day, giving the area in acres (table 1a) and in hectares (table 1b). The daily fire growth area has been calculated as the area within the perimeter outlining each day's growth (excluding bodies of water).

A fire severity map (Despain and others 1989) was produced from satellite imagery after the fires had stopped spreading. We compared the final perimeter of the fire growth map to severity to locate burned areas not included on the headquarters map. Some of the outermost perimeters were matched to the final perimeter shown on the severity map and dated by the fire chronology report. Fires do not burn the vegetation in all areas completely, but leave unburned pockets and irregular perimeters. Large unburned areas within the fires' perimeters were excluded when possible, but the fires burned as mosaics and many small patches of unburned vegetation could not be identified or excluded. Thus the area within a smoothed estimate of final perimeter will overpredict the actual area burned. This problem was discussed by the report of the Burned Area Survey Team (1988) and Despain and others (1989). Figure 3 shows the relationship between the growth perimeters and the burned area as seen by satellite (the basis for the severity map). Tables 2a through 2h show the breakdown of growth areas by severity class by day for each of the major fire complexes.

Table 1a—Area burned per day (acres) for each fire, and totals

Date	Fan	North Fork	Clover-Mist	Hellroaring	Storm Creek	Mink	Snake	Huck	Totals
					Acres				
6/30	52	0	0	0	0	0	0	0	52
7/2	1,844	0	0	0	2,253	0	0	0	4,097
7/3	0	0	0	0	384	0	0	0	384
7/5	210	0	0	0	734	0	246	0	1,190
7/10	288	0	0	0	0	0	0	0	288
7/12	88	0	0	0	0	4	584	0	676
7/13	0	0	207	0	0	166	15	0	388
7/14	0	0	7,133	0	0	4,099	0	0	11,232
7/16	156	0	0	0	0	0	217	0	373
7/17	177	0	767	0	0	9,450	0	0	10,394
7/18	0	0	0	0	0	1,006	522	0	1,528
7/19	0	0	3,472	0	0	875	155	0	4,502
7/20	153	0	0	0	0	2,906	49	0	3,108
7/21	0	0	1,709	0	0	2,625	661	0	4,995
7/22	0	0	12,774	0	0	1,802	3,281	0	17,857
7/23	0	274	10,161	0	0	1,927	5,020	0	17,382
7/24	0	2,277	0	0	0	826	1,265	0	4,368
7/25	0	3,253	1,775	0	0	1,941	6,350	0	13,319
7/26	0	1,874	24,310	0	0	346	277	0	26,807
7/27	0	733	266	0	0	0	2,866	0	3,865

(con.)

Table 1a (Con.)

Date	Fan	North Fork	Clover-Mist	Hellroaring	Storm Creek	Mink	Snake	Huck	Totals
					Acres				
7/28	0	2,119	0	0	0	0	1,061	0	3,180
7/29	0	0	0	0	0	0	843	0	843
7/30	0	509	0	0	0	0	819	0	1,328
7/31	0	7,939	1	0	0	1,625	3,296	0	12,860
8/1	11,338	1,997	322	0	0	0	6,887	0	20,544
8/2	1,223	2,281	3,453	0	0	421	3,068	0	10,446
8/3	590	0	1,547	0	0	1,511	3,514	0	7,162
8/4	3,402	1,817	7,665	0	0	0	5,467	0	18,351
8/5	785	2,242	0	0	0	566	5,608	0	9,201
8/6	3,215	1,634	972	0	0	2,624	2,648	0	11,093
8/7	0	656	0	0	0	0	158	0	814
8/8	829	2,965	2,698	0	0	0	5,167	0	11,659
8/9	549	1,955	3,493	0	0	1,440	1,123	0	8,560
8/10	912	8,023	3,021	0	0	348	204	0	12,508
8/11	0	7,914	6,263	0	0	2,607	622	0	17,406
8/12	0	0	3,849	0	0	689	1,168	0	5,706
8/13	0	2,567	2,690	0	0	735	171	0	6,163
8/14	229	716	764	0	0	24	0	0	1,733
8/15	705	9,026	415	0	0	258	403	0	10,807
8/16	0	2,724	19,386	0	0	1,641	545	0	24,296
8/17	0	5,420	494	1,193	0	0	88	0	7,195
8/18	61	3,575	1,357	2,191	0	3,180	2,034	0	12,398
8/19	0	6,341	7,083	4,902	6,163	3,527	4,182	0	32,198
8/20	0	12,499	55,682	19,875	23,542	32,584	2,204	6,573	152,959
8/21	0	3,954	3,002	368	0	0	17,476	4,565	29,365
8/22	457	10,113	4,207	2,574	0	0	1,498	2,909	21,758
8/23	83	8,757	2,937	0	0	1,175	9,272	4,834	27,058
8/24	0	5,654	1,744	1,968	6,478	981	5,807	3,484	26,116
8/25	0	10,501	5,284	3,070	2,627	0	290	3,304	25,076
8/26	0	5,923	1,491	2,101	0	0	2,781	6,179	18,475
8/27	0	4,224	1,997	2,871	6,570	0	0	890	16,552
8/28	0	5,269	12,797	0	0	0	0	0	18,066
8/29	0	4,276	10,158	523	15,315	16,691	23,709	6,509	77,181
8/30	0	18,657	2,581	2,957	13,521	8,966	38,582	9,799	95,063
8/31	0	6,060	2,784	3,334	4,117	3,390	1,680	353	21,718
9/1	0	6,932	1,913	4,854	240	0	1,023	0	14,962
9/2	0	12,271	1,736	4,900	8,343	0	6,354	0	33,604
9/3	0	16,349	2,583	2,908	5,409	0	0	0	27,249
9/4	0	3,223	1,108	489	3,267	0	0	0	8,087
9/5	0	7,698	1,301	4,298	4,088	1,374	0	8,147	26,906
9/6	0	55,615	24,838	2,156	7,346	572	6,555	8,353	105,435
9/7	0	27,777	33,402	5,740	21,372	0	8,072	29,250	125,613
9/8	0	19,282	31,109	9,215	0	0	0	0	59,606
9/9	0	147,482	23,749	10,682	6,043	9,478	18,459	12,244	228,137
9/10	0	29,218	13,987	7,900	5,849	19,095	7,425	12,353	95,827
9/11	0	269	7,842	0	0	0	0	0	8,111
9/12	0	16,774	1,072	0	0	0	0	0	17,846
9/13	0	0	0	0	0	1,223	1,100	641	2,964
9/14	0	2,531	3,576	0	0	0	0	0	6,107
9/15	0	2,512	0	927	0	0	0	0	3,439
9/16	0	0	431	0	0	0	0	0	431
9/17	0	6,531	0	0	0	0	0	0	6,531
9/22	0	0	2,376	0	0	0	0	0	2,376
9/24	0	0	489	0	0	0	0	0	489
9/25	0	0	2,643	0	0	0	0	0	2,643
9/26	0	0	7,149	0	0	0	0	0	7,149
10/1	0	0	2,254	0	0	0	0	0	2,254
Totals	27,346	531,182	396,268	101,996	143,661	144,698	222,871	120,387	1,688,409

Table 1b—Area burned per day (hectares) for each fire, and totals

Date	Fan	North Fork	Clover-Mist	Hellroaring	Storm Creek	Mink	Snake	Huck	Totals
					Hectares				
6/30	21	0	0	0	0	0	0	0	21
7/2	746	0	0	0	912	0	0	0	1,658
7/3	0	0	0	0	155	0	0	0	155
7/5	85	0	0	0	297	0	100	0	482
7/10	117	0	0	0	0	0	0	0	117
7/12	36	0	0	0	0	0	236	0	272
7/13	0	0	84	0	0	67	6	0	157
7/14	0	0	2,887	0	0	1,659	0	0	4,546
7/16	63	0	0	0	0	0	88	0	151
7/17	72	0	311	0	0	3,824	0	0	4,207
7/18	0	0	0	0	0	407	211	0	618
7/19	0	0	1,405	0	0	354	63	0	1,822
7/20	62	0	0	0	0	1,176	20	0	1,258
7/21	0	0	692	0	0	1,062	268	0	2,022
7/22	0	0	5,170	0	0	729	1,328	0	7,227
7/23	0	111	4,112	0	0	780	2,032	0	7,035
7/24	0	922	0	0	0	334	512	0	1,768
7/25	0	1,317	718	0	0	786	2,570	0	5,391
7/26	0	758	9,838	0	0	140	112	0	10,848
7/27	0	297	108	0	0	0	1,160	0	1,565
7/28	0	858	0	0	0	0	430	0	1,288
7/29	0	0	0	0	0	0	341	0	341
7/30	0	206	0	0	0	0	332	0	538
7/31	0	3,213	1	0	0	658	1,334	0	5,206
8/1	4,588	808	131	0	0	0	2,787	0	8,314
8/2	495	923	1,397	0	0	170	1,242	0	4,227
8/3	239	0	626	0	0	612	1,422	0	2,899
8/4	1,377	736	3,102	0	0	0	2,213	0	7,428
8/5	318	908	0	0	0	229	2,270	0	3,725
8/6	1,301	661	394	0	0	1,062	1,072	0	4,490
8/7	0	266	0	0	0	0	64	0	330
8/8	336	1,200	1,092	0	0	0	2,091	0	4,719
8/9	222	791	1,414	0	0	583	455	0	3,465
8/10	369	3,247	1,223	0	0	141	83	0	5,063
8/11	0	3,203	2,535	0	0	1,055	252	0	7,045
8/12	0	0	1,558	0	0	279	473	0	2,310
8/13	0	1,039	1,089	0	0	298	69	0	2,495
8/14	93	290	309	0	0	10	0	0	702
8/15	285	3,653	168	0	0	104	163	0	4,373
8/16	0	1,103	7,846	0	0	664	221	0	9,834
8/17	0	2,194	200	483	0	0	36	0	2,913
8/18	25	1,447	549	887	0	1,287	823	0	5,018
8/19	0	2,566	2,866	1,984	2,494	1,428	1,692	0	13,030
8/20	0	5,058	22,534	8,044	9,528	13,187	892	2,660	61,903
8/21	0	1,600	1,215	149	0	0	7,072	1,848	11,884
8/22	185	4,093	1,703	1,042	0	0	606	1,177	8,806
8/23	34	3,544	1,189	0	0	476	3,753	1,956	10,952
8/24	0	2,288	706	797	2,622	397	2,350	1,410	10,570
8/25	0	4,250	2,139	1,242	1,063	0	118	1,337	10,149
8/26	0	2,397	604	850	0	0	1,125	2,501	7,477
8/27	0	1,709	808	1,162	2,659	0	0	360	6,698
8/28	0	2,133	5,179	0	0	0	0	0	7,312
8/29	0	1,730	4,111	212	6,198	6,755	9,595	2,634	31,235
8/30	0	7,550	1,045	1,196	5,472	3,628	15,614	3,965	38,470
8/31	0	2,452	1,126	1,349	1,666	1,372	680	143	8,788
9/1	0	2,805	774	1,964	97	0	414	0	6,054
9/2	0	4,966	702	1,983	3,376	0	2,572	0	13,599
9/3	0	6,616	1,045	1,177	2,189	0	0	0	11,027

(con.)

Table 1b (Con.)

Date	Fan	North Fork	Clover-Mist	Hellroaring	Storm Creek	Mink	Snake	Huck	Totals
					Hectares				
9/4	0	1,304	448	198	1,322	0	0	0	3,272
9/5	0	3,116	527	1,739	1,654	556	0	3,297	10,889
9/6	0	22,507	10,052	872	2,973	231	2,653	3,380	42,668
9/7	0	11,241	13,518	2,323	8,649	0	3,267	11,838	50,836
9/8	0	7,803	12,589	3,729	0	0	0	0	24,121
9/9	0	59,685	9,611	4,323	2,446	3,836	7,470	4,955	92,326
9/10	0	11,824	5,660	3,197	2,367	7,727	3,005	4,999	30,779
9/11	0	109	3,173	0	0	0	0	0	3,282
9/12	0	6,788	434	0	0	0	0	0	7,222
9/13	0	0	0	0	0	495	445	259	1,199
9/14	0	1,024	1,447	0	0	0	0	0	2,471
9/15	0	1,017	0	375	0	0	0	0	1,392
9/16	0	0	174	0	0	0	0	0	174
9/17	0	2,643	0	0	0	0	0	0	2,643
9/22	0	0	962	0	0	0	0	0	962
9/24	0	0	198	0	0	0	0	0	198
9/25	0	0	1,069	0	0	0	0	0	1,069
9/26	0	0	2,893	0	0	0	0	0	2,893
10/1	0	0	912	0	0	0	0	0	912
Totals	11,069	214,969	160,372	41,277	58,139	58,558	90,202	48,719	683,305

POINTS OF INTEREST

Even though the fires burned under similar conditions, they often developed unique characteristics; sometimes unusual events distinguished one from another.

Fan Fire—The Fan Fire, burning in the northwestern corner of the park, was initially of great concern because of the possibility it might spread out of Yellowstone National Park onto private lands, posing a threat to the Yellowstone Valley near Gardiner. The fire produced severe behavior in late July and early August. But of all the fires that were fought, it was suppressed most successfully. Although it reached a total size of 27,346 acres (11,069 hectares), it was held without significant growth after the middle of August.

Snake Complex—Initially the Falls, Shoshone, and Red Fires made up the Snake Complex. This complex, which burned together by August 23, was named after the Snake River, which has its headwaters in the southwestern portion of Yellowstone National Park. These fires had the potential to burn extensive acreage in the park due to the prevailing southwesterly winds. Grant Village was the first facility threatened, and tourists were evacuated so defensive preparations could be made. The problem of spot fires from wind-blown firebrands that would frustrate fire control all summer became evident on July 23, when the Shoshone Fire crossed the south entrance highway despite the best efforts of fire crews and the use of aircraft to drop retardant.

The Huck Fire started on August 20, joined the Snake Complex, and burned across the park below Yellowstone Lake. On August 30, the Snake Complex burned into the Mink Creek Fire in the southeastern corner of the park.

Mink Creek Fire—The Mink Creek Fire, started by lightning on the Bridger-Teton National Forest, made significant runs in mid-July. The fire was burning within and near some of the heaviest dead and down fuels encountered throughout the Greater Yellowstone Area. A high-elevation cyclone the year before had laid down timber in a swath nearly 15 miles (24 kilometers) long; the cyclone created a heavy log deck about 3 miles (4.8 kilometers) long and a mile (1.6 kilometers) wide that was now adjacent to the fire. Because of the threat to nearby ranches, the incident command team was instructed to keep the fire from burning into the heaviest of the blowdown. A burnout was conducted on July 20 to isolate the fire from the large log deck. This was done successfully, but the fire moved north following the upper Yellowstone River headwaters, reaching Yellowstone National Park on July 23. After entering the park, the fire curved to the east, burning through the park's southeastern corner and out onto the Shoshone Forest.

The combination of the Snake Complex and the Huck and Mink Fires covered a total of 487,956

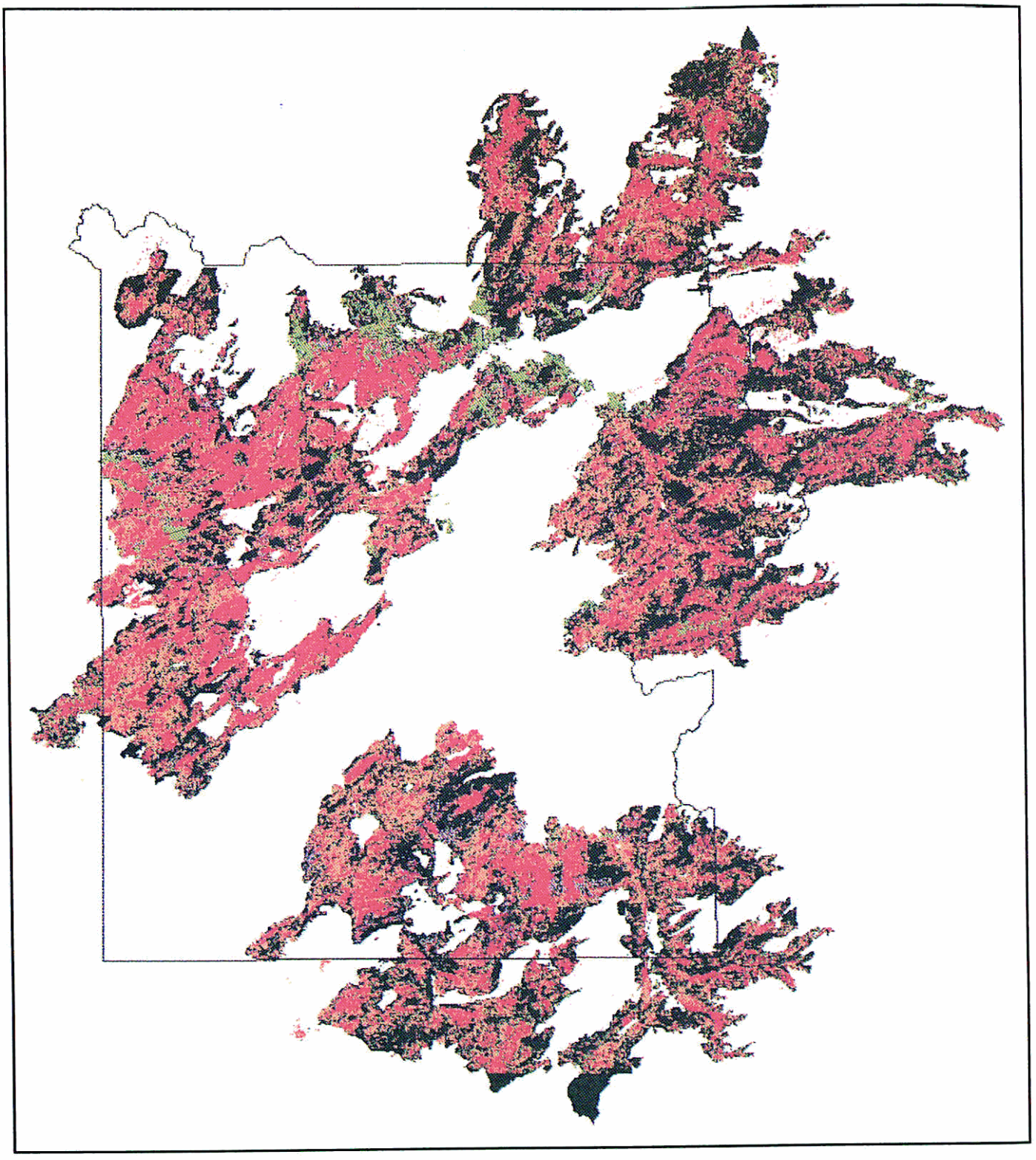


Figure 3—Growth perimeters are shown in black with overlaid colors indicating various levels of fire severity. The fires burned in patches, leaving a mosaic of unburned areas. Areas of red were burned by crown fires, green by surface fires, and yellow by mixed surface and crown fires.

acres (197,479 hectares) straddling the park's southern boundary.

Clover-Mist, Hellroaring, and Storm Creek Fires—The Clover and Mist Fires burned together in mid-July. After merging with several other fires, it became the largest fire complex in the park during July and August, encompassing a total of 232,710 acres (94,184 hectares) by August 31. Since the fire was in the rugged east-central portion of the park, access was all but impossible. Smoke prevented aerial surveillance. The fire made a run toward the open range at the northern end of the Lamar Valley, but it was successfully stopped on August 16 when it burned into a sagebrush-grass area where fire crews had good access. This action prevented the fire from entering the Soda Butte Creek drainage where prevailing southwesterly winds could have taken it into the towns of Silver Gate and Cooke City.

On Saturday, August 20, referred to as Black Saturday, the Clover-Mist Fire burned approximately 55,000 acres (22,500 hectares) just south of Cooke City. On the same day, winds estimated to be over 60 miles per hour (96 kilometers per hour) drove the Hellroaring Fire to the north, completely burning out the trees at the upper end of the Hellroaring drainage. Concurrently, the Storm Creek Fire to the east spread south toward Silver Gate and Cooke City. The magnitude of these three fires was beyond the experience of anyone present. Some fire managers questioned whether the Clover-Mist Fire had caused inflows that pulled the Storm Creek Fire to the south, while the Clover-Mist and Hellroaring Fires were spreading to the north. Investigation at the time concluded that it probably had not, due to the large valleys and mountain ridges between the Clover-Mist and Storm Creek Fires.

During the last week of August and the first week of September, these three fires posed a severe threat to Silver Gate and Cooke City. Bulldozers constructed a broad fuel break just outside the northeast park entrance as a holding line for a burnout operation to protect the towns. Unfortunately, firebrands from the burnout crossed the line (Interagency Congressional Oversight Task Force 1988) and some of the most fervent firefighting of the summer took place to protect Cooke City and Silver Gate.

Table 2a—Percent of perimeter area burned by severity class by day for the Fan Fire in and outside of Yellowstone National Park

	In Yellowstone Park[1]						Outside Yellowstone Park[2]			
Date	Canopy burn	Mixed burn	Nonforest burn	Undifferentiated burn	Water	Unburned	Canopy burn	Mixed burn	Nonforest burn	Other[3]
6/30	35.71	54.76	0.00	1.19	0.00	8.33	0.00	0.00	0.00	0.00
7/2	49.01	36.62	0.10	2.04	0.00	12.23	0.00	0.00	0.00	0.00
7/5	28.53	43.24	0.00	0.00	0.00	28.24	0.00	0.00	0.00	0.00
7/10	21.84	25.48	0.00	1.71	0.00	50.96	0.00	0.00	0.00	0.00
7/12	0.00	68.31	0.00	0.00	0.00	31.69	0.00	0.00	0.00	0.00
7/16	12.25	29.25	0.00	0.79	0.00	57.71	0.00	0.00	0.00	0.00
7/17	7.67	29.62	0.00	2.09	0.00	60.63	0.00	0.00	0.00	0.00
7/20	20.65	47.37	0.40	2.43	0.00	29.15	0.00	0.00	0.00	0.00
8/1	16.16	25.49	1.47	2.01	0.04	54.84	0.00	0.00	0.00	0.00
8/2	8.44	34.71	0.45	0.05	0.00	56.34	0.00	0.00	0.00	0.00
8/3	18.53	32.15	0.00	4.82	0.00	44.50	0.00	0.00	0.00	0.00
8/4	3.61	12.42	0.00	0.78	0.00	83.19	0.00	0.00	0.00	0.00
8/5	3.31	14.88	1.73	1.34	0.00	78.74	0.00	0.00	0.00	0.00
8/6	12.78	10.59	0.27	3.09	0.12	73.16	0.00	0.00	0.00	0.00
8/8	9.09	8.49	1.79	5.66	0.30	74.66	0.00	0.00	0.00	0.00
8/9	7.31	19.46	0.45	1.24	0.00	71.54	0.00	0.00	0.00	0.00
8/10	29.07	29.07	0.20	2.10	0.00	39.57	0.00	0.00	0.00	0.00
8/14	21.83	43.94	2.43	1.35	0.00	30.46	0.00	0.00	0.00	0.00
8/15	15.69	18.40	6.05	4.03	0.00	55.83	0.00	0.00	0.00	0.00
8/18	57.58	24.24	0.00	2.02	0.00	16.16	0.00	0.00	0.00	0.00
8/22	16.89	33.38	10.14	0.81	0.00	38.78	0.00	0.00	0.00	0.00
8/23	5.19	4.44	0.00	0.00	0.00	90.37	0.00	0.00	0.00	0.00

[1]Based on Despain and others (1989). Unburned includes area they calculated as undelineated burn (surface burn under dense, unburned canopies that often appeared unburned to the satellite). Undifferentiated burn consisted of burned areas of varied composition that could not reliably be placed in another category.

[2]The corresponding data within Yellowstone National Park were refined by Despain and others (1989). These figures provide an indication of severity patterns outside park boundaries and are subject to correction as a result of refinement.

[3]Includes unburned lands and water.

Table 2b—Percent of perimeter area burned by severity class by day for the North Fork Fire in and outside of Yellowstone National Park

	In Yellowstone Park[1]						Outside Yellowstone Park[2]			
Date	Canopy burn	Mixed burn	Nonforest burn	Undifferentiated burn	Water	Unburned	Canopy burn	Mixed burn	Nonforest burn	Other[3]
7/23	44.90	40.32	0.00	0.23	0.00	13.51	0.00	1.05	0.00	0.00
7/24	33.15	53.31	0.24	0.90	0.00	12.40	0.00	0.00	0.00	0.00
7/25	34.60	41.09	0.15	0.51	0.00	23.64	0.00	0.00	0.00	0.00
7/26	47.74	32.67	0.26	2.67	0.00	16.65	0.00	0.00	0.00	0.00
7/27	47.51	20.81	0.00	0.59	0.00	31.09	0.00	0.00	0.00	0.00
7/28	23.97	40.35	0.03	1.46	0.00	34.20	0.00	0.00	0.00	0.00
7/30	26.21	57.52	0.00	0.00	0.00	16.26	0.00	0.00	0.00	0.00
7/31	20.68	41.42	1.19	1.16	0.00	35.55	0.00	0.00	0.00	0.01
8/1	10.15	49.29	0.34	1.14	0.00	32.30	0.00	0.00	0.00	6.78
8/2	14.76	41.12	2.71	0.22	0.00	41.20	0.00	0.00	0.00	0.00
8/4	28.62	52.75	0.10	0.00	0.00	18.52	0.00	0.00	0.00	0.00
8/5	43.94	30.96	2.73	1.87	0.00	20.50	0.00	0.00	0.00	0.00
8/6	28.09	37.16	3.33	0.87	0.00	30.55	0.00	0.00	0.00	0.00
8/7	5.27	16.85	9.42	0.75	0.00	67.70	0.00	0.00	0.00	0.00
8/8	24.15	47.88	0.40	2.83	0.00	24.73	0.00	0.00	0.00	0.00
8/9	28.19	55.72	0.66	1.33	0.00	14.10	0.00	0.00	0.00	0.00
8/10	41.48	30.88	3.97	1.82	0.00	21.86	0.00	0.00	0.00	0.00
8/11	58.55	24.31	1.23	3.40	0.14	12.37	0.00	0.00	0.00	0.00
8/13	31.31	32.18	1.85	2.82	0.00	31.84	0.00	0.00	0.00	0.00
8/14	60.14	30.63	0.00	1.04	0.00	8.20	0.00	0.00	0.00	0.00
8/15	52.44	21.06	2.46	2.75	0.34	20.94	0.00	0.00	0.00	0.00
8/16	22.49	37.23	1.54	2.02	0.00	36.71	0.00	0.00	0.00	0.00
8/17	36.02	34.50	0.88	4.02	0.00	24.58	0.00	0.00	0.00	0.00
8/18	34.40	22.40	3.96	4.25	0.00	34.99	0.00	0.00	0.00	0.00
8/19	22.16	32.45	0.42	4.29	0.00	40.68	0.00	0.00	0.00	0.00
8/20	26.26	32.66	1.23	1.76	0.06	38.02	0.00	0.00	0.00	0.00
8/21	7.84	27.03	1.75	0.78	0.00	62.59	0.00	0.00	0.00	0.00
8/22	19.21	30.01	1.80	1.91	0.56	46.52	0.00	0.00	0.00	0.00
8/23	32.41	36.19	2.43	1.12	0.08	27.76	0.00	0.00	0.00	0.00
8/24	28.66	37.67	0.81	0.74	0.17	31.94	0.00	0.00	0.00	0.00
8/25	38.53	33.20	2.91	1.11	0.11	24.15	0.00	0.00	0.00	0.00
8/26	32.78	29.78	1.62	2.11	0.11	31.23	0.98	0.63	0.40	0.38
8/27	13.62	28.68	4.18	2.12	0.00	44.30	3.10	1.74	0.83	1.42
8/28	23.66	31.13	3.52	2.25	0.00	33.26	2.09	1.82	0.94	1.35
8/29	24.47	33.46	3.13	1.31	0.09	37.53	0.00	0.00	0.00	0.00
8/30	37.88	23.11	3.57	2.01	0.25	33.19	0.00	0.00	0.00	0.00
8/31	9.93	26.47	22.01	2.12	0.09	39.38	0.00	0.00	0.00	0.00
9/1	44.16	31.06	4.30	1.37	0.00	19.12	0.00	0.00	0.00	0.00
9/2	23.33	31.51	7.39	2.52	0.33	34.92	0.00	0.00	0.00	0.00
9/3	16.16	16.99	1.80	1.22	0.00	11.93	20.00	8.41	8.15	13.33
9/4	12.25	16.50	0.90	1.00	0.00	31.67	5.96	8.05	5.29	18.38
9/5	18.73	27.77	2.48	3.11	0.30	46.74	0.16	0.14	0.21	0.36
9/6	51.82	19.13	1.26	2.46	0.44	19.27	1.00	1.04	0.99	2.58
9/7	39.21	21.88	8.89	3.33	0.00	26.69	0.00	0.00	0.00	0.00
9/8	33.21	19.96	4.15	2.37	0.19	32.14	0.59	1.18	0.84	5.37
9/9	45.08	15.75	9.90	3.53	0.02	25.66	0.01	0.00	0.02	0.03
9/10	10.83	9.52	26.48	5.72	0.02	47.43	0.00	0.00	0.00	0.00
9/11	2.52	5.28	21.33	7.11	0.00	63.76	0.00	0.00	0.00	0.00
9/12	24.82	17.36	5.44	3.70	0.03	48.64	0.00	0.00	0.00	0.00
9/14	3.47	9.59	3.27	2.88	0.00	38.83	5.44	6.39	7.71	22.41
9/15	20.48	18.37	4.48	2.24	0.00	33.19	5.83	6.20	0.76	8.46
9/17	5.99	11.80	11.80	4.64	0.15	65.01	0.00	0.05	0.00	0.57

[1]Based on Despain and others (1989). Unburned includes area they calculated as undelineated burn (surface burn under dense, unburned canopies that often appeared unburned to the satellite). Undifferentiated burn consisted of burned areas of varied composition that could not reliably be placed in another category.

[2]The corresponding data within Yellowstone National Park were refined by Despain and others (1989). These figures provide an indication of severity patterns outside park boundaries and are subject to correction as a result of refinement.

[3]Includes unburned lands and water.

Table 2c—Percent of perimeter area burned by severity class by day for the Clover-Mist Fire in and outside of Yellowstone National Park

	In Yellowstone Park[1]						Outside Yellowstone Park[2]			
Date	Canopy burn	Mixed burn	Nonforest burn	Undifferentiated burn	Water	Unburned	Canopy burn	Mixed burn	Nonforest burn	Other[3]
7/13	13.73	81.79	0.00	0.60	0.00	3.88	0.00	0.00	0.00	0.00
7/14	25.86	28.35	1.67	2.60	0.00	41.53	0.00	0.00	0.00	0.00
7/17	26.81	30.11	1.77	2.09	0.00	39.21	0.00	0.00	0.00	0.00
7/19	18.50	35.06	0.80	4.02	0.00	41.61	0.00	0.00	0.00	0.00
7/21	33.12	31.20	0.58	3.18	0.00	31.92	0.00	0.00	0.00	0.00
7/22	40.12	24.36	0.69	3.17	0.00	30.92	0.15	0.19	0.04	0.36
7/23	23.94	28.86	0.54	1.67	0.30	42.60	0.22	0.29	0.15	1.42
7/25	3.93	4.42	5.08	0.21	0.00	35.40	1.53	4.84	0.97	43.61
7/26	11.87	21.00	0.90	1.40	0.00	64.83	0.00	0.00	0.00	0.00
7/27	0.23	0.00	0.00	0.00	0.00	0.00	41.30	18.10	9.51	30.86
7/31	0.00	50.00	0.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00
8/1	26.05	46.74	0.57	2.87	0.00	23.75	0.00	0.00	0.00	0.00
8/2	11.65	24.37	0.57	1.77	0.02	60.44	0.82	0.02	0.14	0.20
8/3	9.62	49.34	0.28	2.79	0.00	37.96	0.00	0.00	0.00	0.00
8/4	11.68	21.88	0.89	1.18	0.00	57.55	2.34	1.63	0.08	2.77
8/6	22.68	44.60	0.00	1.02	0.00	31.70	0.00	0.00	0.00	0.00
8/8	11.91	46.71	0.55	2.04	0.09	38.70	0.00	0.00	0.00	0.00
8/9	16.13	38.19	0.32	1.73	0.00	43.63	0.00	0.00	0.00	0.00
8/10	10.84	29.20	0.51	3.05	0.00	56.41	0.00	0.00	0.00	0.00
8/11	10.48	32.54	4.55	2.05	0.00	49.42	0.09	0.09	0.02	0.76
8/12	13.95	33.56	2.09	1.43	0.00	48.77	0.02	0.06	0.00	0.13
8/13	15.69	33.74	3.95	1.49	0.00	45.13	0.00	0.00	0.00	0.00
8/14	11.33	28.56	0.73	2.27	0.00	56.80	0.00	0.00	0.00	0.32
8/15	28.72	34.38	0.74	5.06	0.00	31.10	0.00	0.00	0.00	0.00
8/16	18.43	30.75	4.55	2.60	0.11	43.57	0.00	0.00	0.00	0.00
8/17	18.25	43.25	1.75	0.00	0.00	33.00	0.75	1.00	0.00	2.00
8/18	38.28	31.04	0.00	3.14	0.00	27.54	0.00	0.00	0.00	0.00
8/19	41.60	21.87	3.84	7.20	0.10	25.40	0.00	0.00	0.00	0.00
8/20	35.04	14.20	2.74	4.21	0.00	32.18	3.35	1.74	0.41	6.12
8/21	5.25	16.50	0.82	0.49	0.00	34.98	5.93	5.60	1.11	29.32
8/22	3.61	8.63	2.86	0.95	0.00	28.72	10.85	9.82	1.82	32.72
8/23	3.74	15.73	6.58	2.84	0.00	57.36	1.05	2.94	0.53	9.21
8/24	2.41	1.66	0.11	0.96	0.00	7.12	42.40	18.31	2.62	24.41
8/25	0.00	0.00	0.00	0.00	0.00	0.42	36.45	16.55	6.77	39.81
8/26	0.00	0.00	0.00	0.00	0.00	0.00	17.56	24.69	9.69	48.05
8/27	0.25	1.42	0.40	0.00	0.00	7.73	2.32	13.67	0.77	73.43
8/28	23.51	26.84	1.15	1.76	0.00	27.15	3.95	2.86	0.97	11.80
8/29	18.49	25.41	0.88	0.27	0.06	23.61	4.49	6.67	1.38	18.74
8/30	2.58	10.41	0.10	0.45	0.24	22.93	1.44	7.47	1.70	52.68
8/31	2.75	12.09	0.29	0.09	0.00	12.58	9.45	12.41	2.31	48.02
9/1	12.73	30.98	0.19	0.13	0.00	17.76	2.78	10.11	1.42	23.90
9/2	23.42	24.45	1.28	0.75	0.00	26.83	2.81	5.77	1.00	13.70
9/3	11.62	18.97	7.63	0.55	0.00	27.89	2.58	7.94	0.81	22.00
9/4	0.56	7.47	0.06	0.06	0.33	15.94	8.97	15.05	2.45	49.11
9/5	2.47	18.71	1.52	1.09	0.00	29.30	5.70	10.87	3.61	26.73
9/6	2.46	6.39	0.22	0.32	0.00	9.18	36.94	9.43	8.60	26.47
9/7	0.16	0.78	0.02	0.00	0.00	0.64	25.73	13.27	8.59	50.81
9/8	1.01	1.31	0.07	0.04	0.30	1.84	41.27	12.77	5.28	36.12
9/9	0.02	0.07	0.35	0.00	0.00	1.10	10.13	12.91	3.37	72.07
9/10	2.95	7.93	5.57	0.78	0.99	26.57	9.97	6.90	5.22	33.13
9/11	0.00	0.00	0.00	0.00	0.00	0.00	17.65	17.19	7.22	57.95
9/12	0.00	0.00	0.00	0.00	0.00	0.00	10.94	16.36	14.34	58.35
9/14	0.00	0.00	0.00	0.00	0.00	0.00	23.82	16.08	14.98	45.12
9/16	0.00	0.00	0.00	0.00	0.00	0.00	1.58	15.35	3.87	79.20
9/22	0.00	0.00	0.00	0.00	0.00	0.00	2.65	5.46	3.20	88.69
9/24	0.00	0.00	0.00	0.00	0.00	0.00	10.48	11.11	4.17	74.24
9/25	0.00	0.00	0.00	0.00	0.00	0.00	23.96	8.11	12.27	55.66
9/26	0.00	0.00	0.00	0.00	0.00	0.00	16.97	14.40	2.33	66.30
10/1	0.00	0.00	0.00	0.00	0.00	0.00	15.24	12.91	16.12	55.73

[1]Based on Despain and others (1989). Unburned includes area they calculated as undelineated burn (surface burn under dense, unburned canopies that often appeared unburned to the satellite). Undifferentiated burn consisted of burned areas of varied composition that could not reliably be placed in another category.

[2]The corresponding data within Yellowstone National Park were refined by Despain and others (1989). These figures provide an indication of severity patterns outside park boundaries and are subject to correction as a result of refinement.

[3]Includes unburned lands and water.

Table 2d—Percent of perimeter area burned by severity class by day for the Hellroaring Fire in and outside of Yellowstone National Park

	In Yellowstone Park[1]						Outside Yellowstone Park[2]			
Date	Canopy burn	Mixed burn	Nonforest burn	Undifferentiated burn	Water	Unburned	Canopy burn	Mixed burn	Nonforest burn	Other[3]
8/17	0.00	0.00	0.00	0.00	0.00	0.00	10.82	43.29	1.71	44.17
8/18	0.00	0.00	0.00	0.00	0.00	0.00	52.17	29.41	2.79	15.62
8/19	0.00	0.00	0.00	0.00	0.00	0.00	30.81	22.43	5.26	41.50
8/20	0.00	0.00	0.00	0.00	0.00	0.00	36.32	13.15	5.70	44.83
8/21	0.00	0.00	0.00	0.00	0.00	0.00	1.18	5.21	0.00	93.61
8/22	0.00	0.00	0.00	0.00	0.00	0.00	12.43	18.00	0.98	68.58
8/24	0.00	0.00	0.00	0.00	0.00	0.00	11.14	19.77	0.50	68.58
8/25	0.00	0.00	0.00	0.00	0.00	0.00	20.99	17.99	3.46	57.56
8/26	0.00	0.00	0.00	0.00	0.00	0.00	3.09	7.53	0.09	89.30
8/27	0.56	1.42	0.17	0.28	0.00	0.73	31.65	37.59	5.60	21.99
8/29	2.01	7.20	0.12	0.83	0.00	3.66	12.87	38.25	6.49	28.57
8/30	1.90	1.57	0.00	0.94	0.00	0.69	25.41	28.21	5.04	36.25
8/31	47.75	17.47	0.24	7.34	0.00	15.58	1.15	5.24	0.28	4.95
9/1	13.36	16.37	0.67	4.53	0.00	22.58	5.99	17.29	0.94	18.26
9/2	1.11	2.55	0.39	0.61	0.00	16.25	16.43	26.01	2.09	34.57
9/3	4.97	10.37	0.55	2.53	0.00	30.93	6.44	16.25	1.53	26.43
9/4	9.85	34.09	0.51	0.38	0.00	30.30	0.00	4.17	0.00	20.71
9/5	1.65	4.44	0.86	1.24	0.00	18.65	3.41	21.70	1.05	47.00
9/6	16.36	7.16	3.04	6.39	0.00	48.60	2.69	5.73	0.57	9.46
9/7	3.44	5.05	0.76	1.43	0.00	27.94	5.76	13.03	0.52	42.07
9/8	3.42	7.96	14.30	1.73	0.00	70.85	0.27	0.11	0.27	1.09
9/9	1.49	2.62	6.81	3.13	0.09	20.76	2.23	9.32	0.56	53.01
9/10	0.72	8.30	13.44	5.08	0.19	72.26	0.00	0.00	0.00	0.00
9/15	0.27	1.27	20.59	0.47	0.00	62.62	0.00	3.46	0.00	11.33

[1]Based on Despain and others (1989). Unburned includes area they calculated as undelineated burn (surface burn under dense, unburned canopies that often appeared unburned to the satellite). Undifferentiated burn consisted of burned areas of varied composition that could not reliably be placed in another category.
[2]The corresponding data within Yellowstone National Park were refined by Despain and others (1989). These figures provide an indication of severity patterns outside park boundaries and are subject to correction as a result of refinement.
[3]Includes unburned lands and water.

Table 2e—Percent of perimeter area burned by severity class by day for the Storm Creek Fire in and outside of Yellowstone National Park

	In Yellowstone Park[1]						Outside Yellowstone Park[2]			
Date	Canopy burn	Mixed burn	Nonforest burn	Undifferentiated burn	Water	Unburned	Canopy burn	Mixed burn	Nonforest burn	Other[3]
7/2	0.00	0.00	0.00	0.00	0.00	0.00	19.58	18.67	1.32	60.43
7/3	0.00	0.00	0.00	0.00	0.00	0.00	13.53	6.12	4.83	75.52
7/5	0.00	0.00	0.00	0.00	0.00	0.00	18.67	16.48	5.05	59.80
8/19	0.00	0.00	0.00	0.00	0.00	0.00	9.74	10.21	16.95	63.10
8/20	0.00	0.00	0.00	0.00	0.00	0.00	41.16	16.68	10.30	31.86
8/24	0.00	0.00	0.00	0.00	0.00	0.00	22.62	16.12	5.65	55.61
8/25	0.00	0.00	0.00	0.00	0.00	0.00	11.15	21.47	1.95	65.44
8/27	0.00	0.00	0.00	0.00	0.00	0.00	7.70	7.31	4.17	80.82
8/29	0.00	0.00	0.00	0.00	0.00	0.00	10.66	6.42	6.99	75.93
8/30	0.00	0.00	0.00	0.00	0.00	0.00	32.29	26.22	5.19	36.31
8/31	0.00	0.00	0.00	0.00	0.00	0.00	35.08	29.95	7.74	27.22
9/1	0.00	0.00	0.00	0.00	0.00	0.00	20.10	23.20	7.47	49.23
9/2	0.41	0.29	0.00	0.35	0.00	3.23	45.25	21.78	4.16	24.54
9/3	17.92	6.88	7.41	8.95	0.00	18.34	21.16	8.02	2.75	8.57
9/4	11.44	12.88	7.85	2.74	0.00	44.15	6.11	4.61	1.19	9.04
9/5	30.01	19.36	0.30	0.54	0.00	22.61	10.73	9.05	1.35	6.05
9/6	7.99	10.86	0.51	3.78	0.00	30.00	8.54	13.70	3.78	20.86
9/7	1.50	2.57	0.61	0.53	0.00	14.67	30.81	13.65	6.30	29.36
9/9	0.00	0.00	0.00	0.00	0.00	0.00	14.56	14.95	6.31	64.19
9/10	0.59	6.45	6.09	0.13	0.00	40.23	2.76	4.97	1.13	37.64

[1]Based on Despain and others (1989). Unburned includes area they calculated as undelineated burn (surface burn under dense, unburned canopies that often appeared unburned to the satellite). Undifferentiated burn consisted of burned areas of varied composition that could not reliably be placed in another category.
[2]The corresponding data within Yellowstone National Park were refined by Despain and others (1989). These figures provide an indication of severity patterns outside park boundaries and are subject to correction as a result of refinement.
[3]Includes unburned lands and water.

Table 2f—Percent of perimeter area burned by severity class by day for the Mink Fire in and outside of Yellowstone National Park

	In Yellowstone Park[1]						Outside Yellowstone Park[2]			
Date	Canopy burn	Mixed burn	Nonforest burn	Undifferentiated burn	Water	Unburned	Canopy burn	Mixed burn	Nonforest burn	Other[3]
7/12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	66.67	0.00	33.33
7/13	0.00	0.00	0.00	0.00	0.00	0.00	1.86	26.77	2.97	68.40
7/14	0.00	0.00	0.00	0.00	0.00	0.00	13.97	19.86	10.23	55.94
7/17	0.00	0.00	0.00	0.00	0.00	0.00	14.70	24.97	7.84	52.50
7/18	0.00	0.00	0.00	0.00	0.00	0.00	4.48	18.92	0.92	75.68
7/19	0.00	0.00	0.00	0.00	0.00	0.00	5.36	5.43	0.49	88.71
7/20	0.00	0.00	0.00	0.00	0.00	0.00	1.45	5.85	0.11	92.60
7/21	0.00	0.00	0.00	0.00	0.00	0.00	8.12	10.57	4.24	77.08
7/22	0.00	0.00	0.07	0.00	0.00	0.03	22.90	11.86	14.81	50.33
7/23	0.32	0.51	0.00	0.00	0.00	0.13	2.60	15.00	0.83	80.61
7/24	12.64	10.10	10.70	3.52	0.00	62.08	0.00	0.30	0.07	0.60
7/25	16.26	5.51	0.64	5.54	0.00	29.50	3.41	13.27	2.67	23.20
7/26	16.79	42.14	0.36	2.14	0.00	38.57	0.00	0.00	0.00	0.00
7/31	0.00	0.04	0.00	0.08	0.00	10.99	9.20	27.79	3.27	48.63
8/2	23.94	25.99	1.03	1.91	0.00	47.14	0.00	0.00	0.00	0.00
8/3	15.74	37.00	4.66	2.33	0.00	40.27	0.00	0.00	0.00	0.00
8/5	17.36	38.54	2.84	1.31	0.00	39.96	0.00	0.00	0.00	0.00
8/6	17.07	34.06	3.06	2.10	0.00	43.71	0.00	0.00	0.00	0.00
8/9	18.02	39.98	0.69	2.79	0.00	38.52	0.00	0.00	0.00	0.00
8/10	27.13	30.85	1.24	7.27	0.00	33.51	0.00	0.00	0.00	0.00
8/11	11.58	35.49	0.09	3.65	0.00	49.18	0.00	0.00	0.00	0.00
8/12	23.57	58.33	0.00	0.09	0.00	18.01	0.00	0.00	0.00	0.00
8/13	20.17	41.60	0.00	2.02	0.00	34.29	0.76	0.34	0.25	0.59
8/14	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
8/15	7.91	46.76	0.24	1.44	0.00	43.65	0.00	0.00	0.00	0.00
8/16	14.57	43.36	1.13	2.22	0.00	38.58	0.00	0.11	0.04	0.00
8/18	28.63	28.69	0.85	3.81	0.00	30.63	0.99	4.90	0.10	1.40
8/19	17.48	30.11	0.68	2.12	0.00	49.61	0.00	0.00	0.00	0.00
8/20	6.95	8.79	1.53	1.45	0.00	22.73	13.20	16.76	2.49	26.10
8/23	11.15	31.76	5.31	4.47	0.00	47.32	0.00	0.00	0.00	0.00
8/24	24.43	23.30	2.14	4.09	0.00	46.03	0.00	0.00	0.00	0.00
8/29	0.11	0.19	0.00	0.00	0.00	0.14	24.67	25.89	2.77	46.22
8/30	4.37	11.84	0.31	0.66	0.00	10.62	17.65	16.09	4.82	33.64
8/31	17.81	24.35	1.04	2.42	0.00	54.38	0.00	0.00	0.00	0.00
9/5	0.00	0.00	0.00	0.00	0.00	0.00	7.01	25.53	1.62	65.84
9/6	4.21	16.31	0.43	5.40	0.00	73.65	0.00	0.00	0.00	0.00
9/9	0.33	2.46	0.18	0.01	0.00	15.77	10.88	20.13	2.25	47.99
9/10	0.14	0.44	0.36	0.10	0.00	3.86	13.28	20.10	3.03	58.68
9/13	5.25	13.89	0.00	2.68	0.00	78.18	0.00	0.00	0.00	0.00

[1]Based on Despain and others (1989). Unburned includes area they calculated as undelineated burn (surface burn under dense, unburned canopies that often appeared unburned to the satellite). Undifferentiated burn consisted of burned areas of varied composition that could not reliably be placed in another category.

[2]The corresponding data within Yellowstone National Park were refined by Despain and others (1989). These figures provide an indication of severity patterns outside park boundaries and are subject to correction as a result of refinement.

[3]Includes unburned lands and water.

Table 2g—Percent of perimeter area burned by severity class by day for the Snake Fire in and outside of Yellowstone National Park

	In Yellowstone Park[1]						Outside Yellowstone Park[2]			
Date	Canopy burn	Mixed burn	Nonforest burn	Undifferentiated burn	Water	Unburned	Canopy burn	Mixed burn	Nonforest burn	Other[3]
7/5	11.06	56.28	0.00	0.00	0.00	32.66	0.00	0.00	0.00	0.00
7/12	23.28	52.91	1.16	0.42	0.32	21.90	0.00	0.00	0.00	0.00
7/13	0.00	45.83	0.00	0.00	0.00	54.17	0.00	0.00	0.00	0.00
7/16	27.27	36.65	0.00	1.70	0.00	34.38	0.00	0.00	0.00	0.00
7/18	4.14	40.66	0.00	2.01	0.59	52.60	0.00	0.00	0.00	0.00
7/19	2.79	37.85	1.20	2.39	0.00	55.78	0.00	0.00	0.00	0.00
7/20	6.33	17.72	0.00	2.53	0.00	73.42	0.00	0.00	0.00	0.00
7/21	15.14	39.07	0.00	4.21	0.00	41.59	0.00	0.00	0.00	0.00
7/22	15.53	42.50	0.00	1.36	0.04	38.58	0.70	0.43	0.13	0.73
7/23	11.76	39.08	0.62	0.42	0.14	46.88	0.32	0.47	0.10	0.22
7/24	18.03	45.63	0.00	0.44	0.00	35.91	0.00	0.00	0.00	0.00
7/25	31.50	40.75	0.00	0.66	0.21	26.87	0.00	0.00	0.00	0.00
7/26	12.05	59.15	0.00	1.79	0.00	27.01	0.00	0.00	0.00	0.00
7/27	11.29	47.67	0.45	0.62	0.00	39.96	0.00	0.00	0.00	0.00
7/28	11.82	36.38	0.12	0.41	0.64	50.64	0.00	0.00	0.00	0.00
7/29	21.04	47.51	0.07	0.22	0.00	31.16	0.00	0.00	0.00	0.00
7/30	16.52	50.45	0.00	0.38	0.00	32.65	0.00	0.00	0.00	0.00
7/31	26.77	26.77	0.90	4.20	0.00	41.37	0.00	0.00	0.00	0.00
8/1	27.69	31.73	1.09	3.94	1.73	33.82	0.00	0.00	0.00	0.00
8/2	14.66	35.39	1.13	10.57	2.11	36.14	0.00	0.00	0.00	0.00
8/3	35.83	41.28	0.00	1.04	0.86	20.99	0.00	0.00	0.00	0.00
8/4	24.12	40.56	1.49	3.21	2.31	28.31	0.00	0.00	0.00	0.00
8/5	12.55	42.89	1.72	4.27	1.28	37.29	0.00	0.00	0.00	0.00
8/6	14.30	41.60	0.61	5.97	1.96	35.56	0.00	0.00	0.00	0.00
8/7	5.49	61.96	0.00	2.35	0.00	30.20	0.00	0.00	0.00	0.00
8/8	21.52	45.59	3.35	2.34	2.09	25.10	0.00	0.00	0.00	0.00
8/9	16.83	40.10	3.08	1.82	0.00	38.17	0.00	0.00	0.00	0.00
8/10	18.18	23.94	4.55	3.03	3.64	46.67	0.00	0.00	0.00	0.00
8/11	10.92	36.74	4.17	2.38	0.00	45.78	0.00	0.00	0.00	0.00
8/12	18.88	33.10	3.17	17.93	4.28	22.63	0.00	0.00	0.00	0.00
8/13	17.03	67.03	0.00	0.36	0.36	15.22	0.00	0.00	0.00	0.00
8/15	16.39	45.64	0.77	4.29	2.60	30.32	0.00	0.00	0.00	0.00
8/16	9.52	36.62	3.74	1.25	0.00	48.87	0.00	0.00	0.00	0.00
8/17	0.70	40.85	0.00	0.00	0.00	58.45	0.00	0.00	0.00	0.00
8/18	24.82	46.20	0.03	1.55	0.12	27.28	0.00	0.00	0.00	0.00
8/19	23.84	41.23	2.50	4.06	0.07	28.29	0.00	0.00	0.00	0.00
8/20	33.36	25.57	0.00	3.67	0.00	37.40	0.00	0.00	0.00	0.00
8/21	25.97	26.32	0.39	4.61	0.25	42.46	0.00	0.00	0.00	0.00
8/22	1.07	11.79	0.12	0.29	0.04	86.68	0.00	0.00	0.00	0.00
8/23	21.35	35.56	0.73	3.26	0.53	38.57	0.00	0.00	0.00	0.00
8/24	36.49	38.17	1.00	0.79	0.24	23.32	0.00	0.00	0.00	0.00
8/25	36.38	59.57	0.00	0.85	0.00	3.19	0.00	0.00	0.00	0.00
8/26	42.63	24.90	0.00	3.89	0.00	28.45	0.00	0.11	0.00	0.02
8/29	40.82	23.51	2.63	5.23	0.41	27.39	0.00	0.00	0.00	0.00
8/30	35.85	22.33	1.52	5.53	0.21	34.57	0.00	0.00	0.00	0.00
8/31	1.51	2.98	0.00	0.00	0.88	94.63	0.00	0.00	0.00	0.00
9/1	29.65	35.51	0.91	2.23	0.00	31.70	0.00	0.00	0.00	0.00
9/2	16.50	24.25	1.50	3.09	0.14	54.53	0.00	0.00	0.00	0.00
9/6	17.81	14.90	1.89	4.39	0.06	60.95	0.00	0.00	0.00	0.00
9/7	18.44	36.64	0.21	10.74	0.01	33.96	0.00	0.00	0.00	0.00
9/9	16.59	25.86	1.07	3.94	0.28	52.26	0.00	0.00	0.00	0.00
9/10	13.58	19.14	5.42	5.66	1.14	55.06	0.00	0.00	0.00	0.00
9/13	18.31	33.03	0.00	3.20	0.00	45.45	0.00	0.00	0.00	0.00

[1]Based on Despain and others (1989). Unburned includes area they calculated as undelineated burn (surface burn under dense, unburned canopies that often appeared unburned to the satellite). Undifferentiated burn consisted of burned areas of varied composition that could not reliably be placed in another category.

[2]The corresponding data within Yellowstone National Park were refined by Despain and others (1989). These figures provide an indication of severity patterns outside park boundaries and are subject to correction as a result of refinement.

[3]Includes unburned lands and water.

Table 2h—Percent of perimeter area burned by severity class by day for the Huck Fire in and outside of Yellowstone National Park

	In Yellowstone Park[1]						Outside Yellowstone Park[2]			
Date	Canopy burn	Mixed burn	Nonforest burn	Undifferentiated burn	Water	Unburned	Canopy burn	Mixed burn	Nonforest burn	Other[3]
8/20	0.00	0.00	0.00	0.00	0.00	0.00	42.43	30.93	4.60	22.05
8/21	0.00	0.00	0.00	0.00	0.00	0.00	19.46	27.67	7.70	45.17
8/22	0.00	0.00	0.00	0.00	0.00	0.00	13.95	40.16	4.74	41.16
8/23	0.00	0.00	0.00	0.00	0.00	0.00	20.81	28.65	6.77	43.77
8/24	0.00	0.00	0.00	0.00	0.00	0.00	27.50	32.09	3.05	37.36
8/25	0.00	0.00	0.00	0.00	0.00	0.00	13.42	28.25	3.23	55.09
8/26	0.00	0.00	0.00	0.00	0.00	0.00	11.49	26.40	5.11	57.00
8/27	0.00	0.00	0.00	0.00	0.00	0.00	2.71	16.04	4.03	77.22
8/29	0.00	0.00	0.00	0.00	0.00	0.00	12.16	20.73	3.37	63.74
8/30	6.76	4.59	0.95	0.96	0.06	5.51	24.49	19.22	3.11	34.35
8/31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.94	1.05	86.01
9/5	1.47	6.22	0.00	0.80	0.00	6.39	29.42	22.76	4.77	28.18
9/6	0.00	0.00	0.00	0.00	0.00	0.00	16.84	29.97	6.21	46.98
9/7	6.24	2.51	0.00	1.12	0.00	2.12	23.31	17.97	6.93	39.80
9/9	11.07	16.97	0.70	4.25	0.00	37.74	3.93	8.46	0.58	16.29
9/10	5.47	7.02	0.09	0.74	0.00	13.47	18.76	19.67	4.83	29.96
9/13	5.69	14.75	1.06	0.39	0.00	42.24	8.49	7.91	0.77	18.71

[1]Based on Despain and others (1989). Unburned includes area they calculated as undelineated burn (surface burn under dense, unburned canopies that often appeared unburned to the satellite). Undifferentiated burn consisted of burned areas of varied composition that could not reliably be placed in another category.
[2]The corresponding data within Yellowstone National Park were refined by Despain and others (1989). These figures provide an indication of severity patterns outside park boundaries and are subject to correction as a result of refinement.
[3]Includes unburned lands and water.

The Clover-Mist Fire continued to spread to the east, with fingers burning into the Clark Fork Valley where many homes and structures were located. Some of the heaviest damage to personal property took place in this area.

One of the most dramatic single runs by any of the fires took place on the south end of the Clover-Mist Fire in the evening and early morning of September 6 and 7; the fire ran 14 miles out of the park, burning over 37,000 acres (15,000 hectares) in Jones Creek near the park's southeast entrance.

North Fork Fire—The North Fork Fire was started July 22 just outside the western boundary of the park by a woodcutter on the Targhee Forest. It became the Greater Yellowstone Area's largest fire, burning across 531,182 acres (214,969 hectares) by the end of the burning season. For administrative and logistic purposes, the north end of the North Fork Fire was designated the Wolf Lake Fire. The North Fork Fire was fought from the time it was discovered. At first, it was viewed as a threat to the Old Faithful area, but driven by prevailing southwesterly winds, it spread to the northeast. This fire systematically overran most of the facility complexes within the park. Madison Junction Campground was endangered on August 15; the humidity dropped to single digits and the wind gusted to 35 miles per hour (56 kilometers per hour). The North Fork Fire crossed the highway and jumped the Madison River as it headed up the Gibbon Valley toward Norris. The fire reached Norris Junction on August 20 and burned past the junction on the 22d, continuing to the northeast toward Canyon Village. Three days later, on August 25, it split to the north and south of the village. Extraordinary defensive actions by fire crews averted loss at these three facilities.

Even West Yellowstone, outside the west entrance, was threatened by the North Fork Fire when downcanyon winds began spreading the fire to the west and out of the park. The fire made significant runs from the first through the third of September. Fortunately, it was held south of the town. But holding the fire did not stop the smoke. Every morning in late summer, residents of West Yellowstone awoke to a fog of smoke enveloping the town.

By the end of the first week of September, the dry cold fronts that were causing the strong southwesterly winds increased in strength and frequency. Winds on the 6th and 7th of September caused the North Fork Fire to spread toward Old Faithful. Again, fire crews saved all but a few minor structures as firebrands spotted across the valley and the fire ran past this major tourist attraction.

Yellowstone National Park Headquarters at Mammoth was also threatened by the fire's progress northward. On the night of September 9 and the early morning of the 10th, the fire reached the road approaches to Mammoth and was burning down the north slope of Bunsen Peak, just south of the community. Fortunately, the weather changed before the flames reached Mammoth. The humidity rose, rain began, and snow capped the higher peaks.

Although suppression action continued for some weeks, the Yellowstone Fires of 1988 posed no more threats.

Comparisons of the sizes of other large fires may help to give some perspective to the growth of the Yellowstone Fires. The Sundance Fire that spread 16 miles (26 kilometers) across northern Idaho in 1967 covered 55,000 acres (22,300 hectares) in 1 day (Anderson 1968). The Canyon Creek Fire, driven by a surfacing jet stream (Goens 1990), spread 23 miles (37 kilometers) in two large fronts on September 6 and 7, 1988, covering 165,000 acres (66,800 hectares) on those 2 days. Over 3 million acres (1.2 million hectares) were estimated to have burned in northern Idaho and western Montana during the great 1910 fires (Koch, n.d.). Most of the fire growth occurred during a 4-day period from August 20 to 23. During the 5-day period from September 6 through 10, the North Fork Fire in Yellowstone National Park grew by 279,374 acres (113,060 hectares). During this period the total size of fires in the Greater Yellowstone Area increased by 614,618 acres (240,730 hectares). The area encompassed by the final perimeter of the 1988 Yellowstone Fires was about 1.7 million acres (690,000 hectares). Within the park, the actual burn area was about 65 percent of the perimeter area (estimated from the severity maps of Despain [1989], after accounting for irregular fire perimeter and islands of unburned fuel).

REFERENCES

Anderson, Hal E. 1968. Sundance Fire: an analysis of fire phenonema. Res. Pap. INT-56. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 39 p.

Burned Area Survey Team. 1988. Preliminary burned area survey of Yellowstone National Park and adjoining National Forests. Yellowstone National Park, WY: Greater Yellowstone Post-Fire Resource Assessment Committee, U.S. Department of the Interior, National Park Service; U.S. Department of Agriculture, Forest Service; National Aeronautics and Space Administration; Montana State University. 27 p.

Despain, Don; Rodman, Ann; Schullery, Paul; Shovic, Henry. 1989. Burned area survey of Yellowstone National Park: the fires of 1988. Yellowstone National Park, WY: U.S. Department of the Interior, National Park Service, Yellowstone National Park. 14 p.

Goens, David W. 1990. Meteorological factors contributing to the Canyon Creek blowup, September 6 and 7, 1988. In: Proceedings, fifth conference on mountain meteorology; 1990 June 25-29; Boulder, CO. Boston, MA: American Meteorological Society: 180-186.

Interagency Congressional Oversight Task Force. 1988. Greater Yellowstone Area Fire Situation 1988. [Phase I report]. West Yellowstone, MT: U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, National Park Service. 60 p.

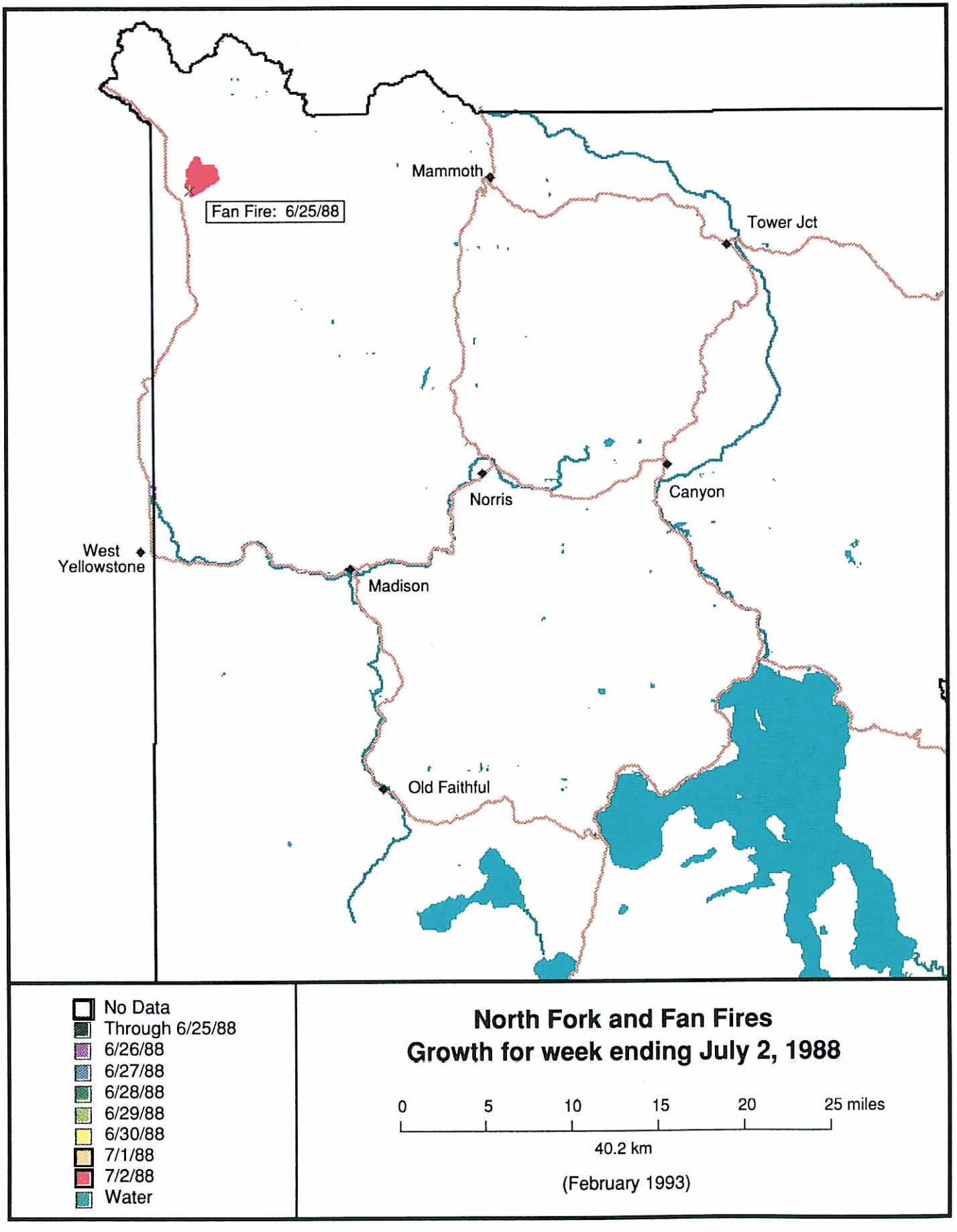
Koch, Elers. [n.d.]. History of the 1910 forest fires in Idaho and western Montana. [Publisher unknown]. On file at: U.S. Department of Agriculture, Intermountain Research Station, Intermountain Fire Sciences Laboratory, Fire Behavior Research Work Unit, Missoula, MT. 25 p.

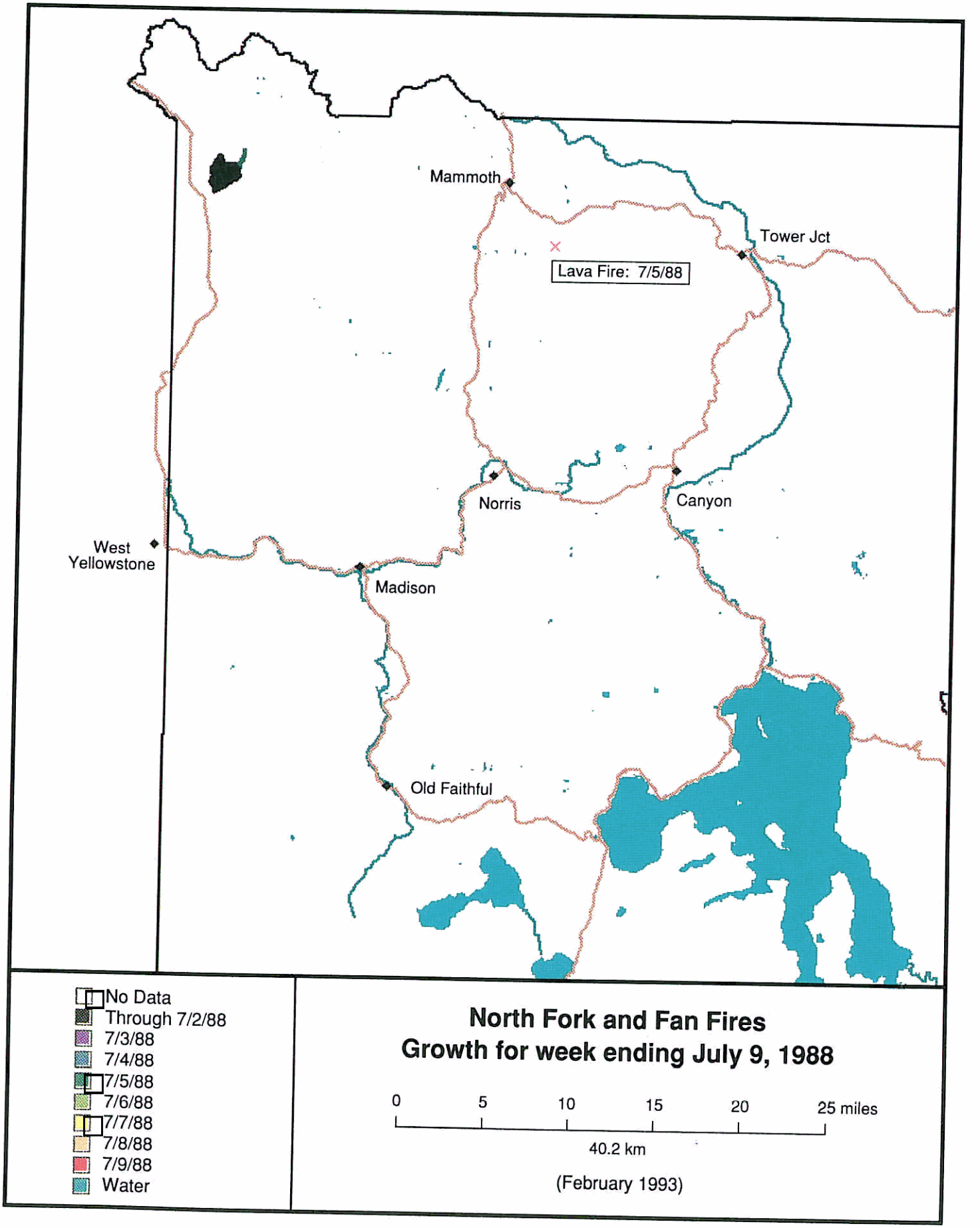
U.S. Army Construction Engineering Research Laboratory. 1988. Geographic Resource Analysis Support System (GRASS)—users and programmer's manual. USA-CERL ADP Rep. N-87/22. Champaign, IL: Environmental Division, U.S. Army Construction Engineering Research Laboratory.

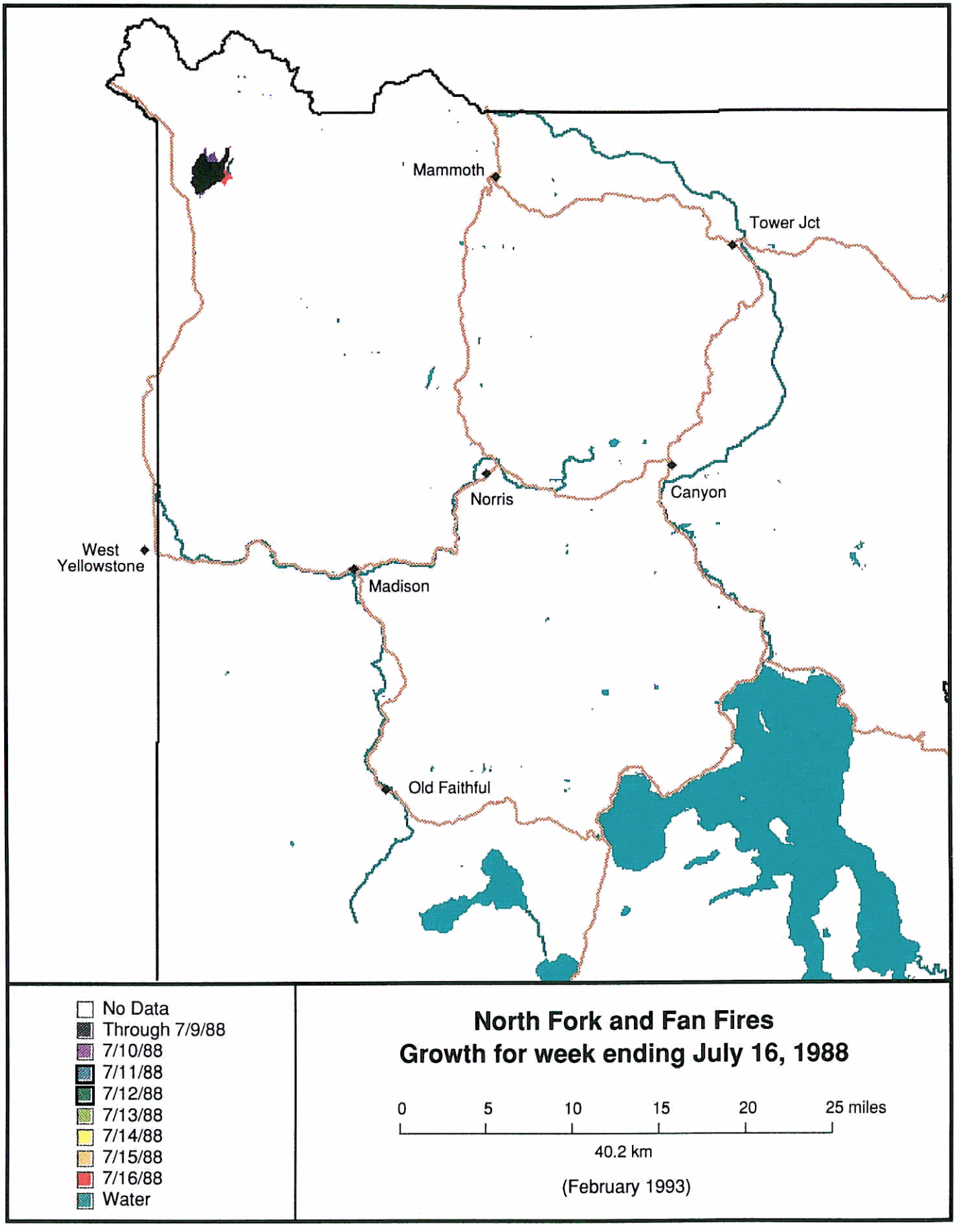
U.S. Department of Agriculture; U.S. Department of the Interior. 1988. Greater Yellowstone Area Fire Situation, 1988. [Phase II Report]. Lakewood, CO: U.S. Department of Agriculture, Forest Service, Region 2; National Park Service, Rocky Mountain Region. 207 p.

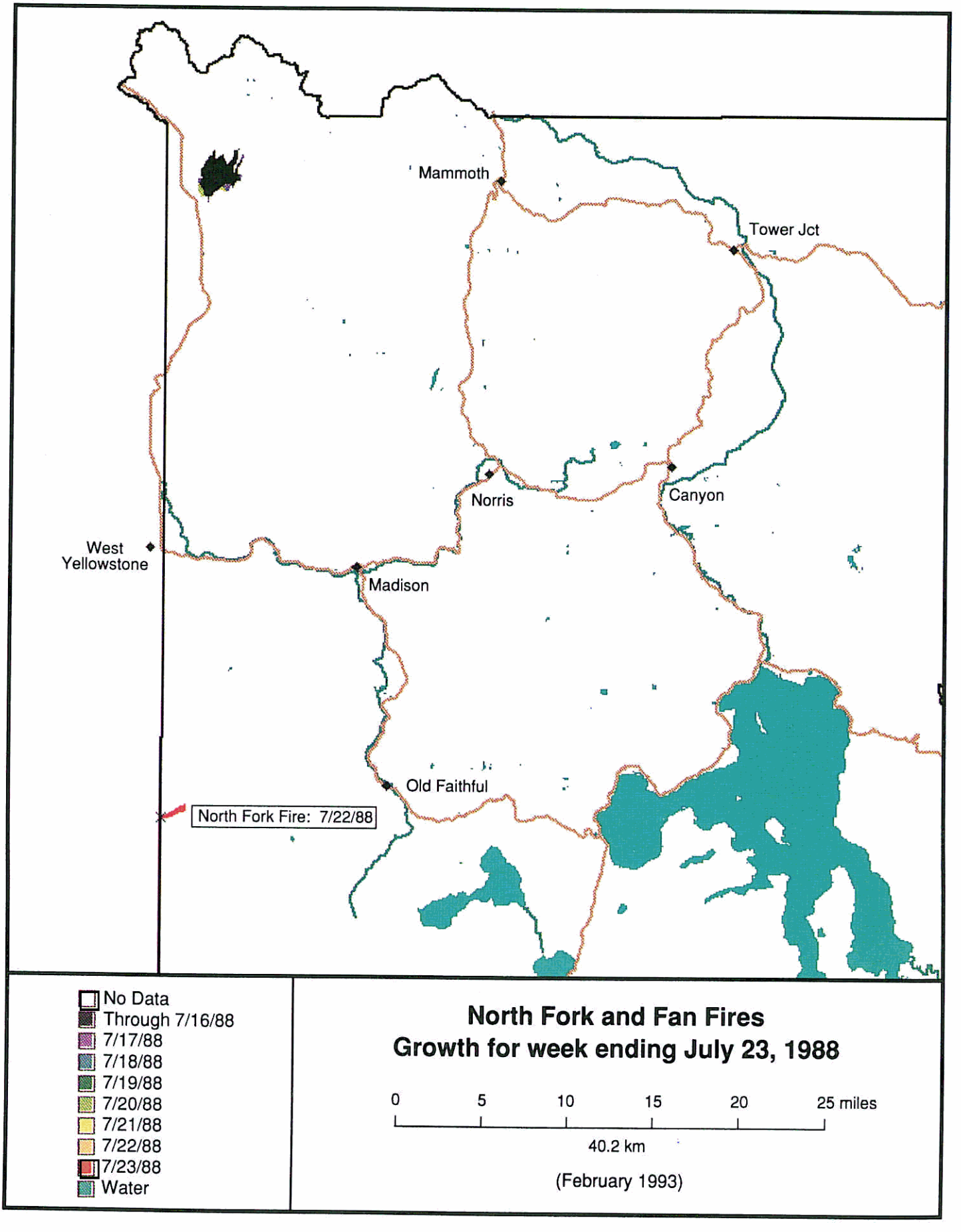
APPENDIX A: FIRE GROWTH MAPS

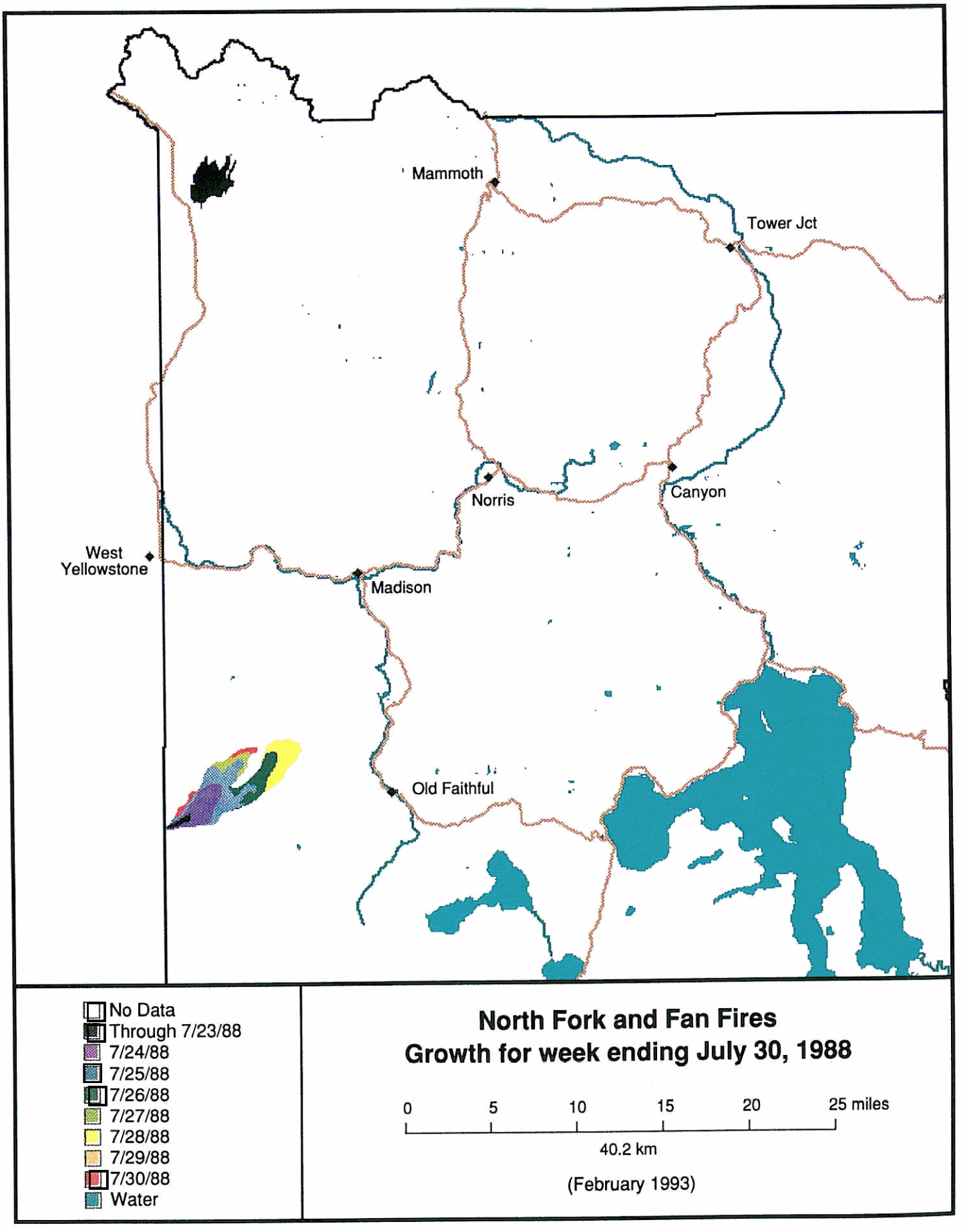
To permit larger scale maps of growth through the summer, only portions of the Greater Yellowstone Area are shown. Figure 1 shows the windows of coverage appearing in each of the following series.

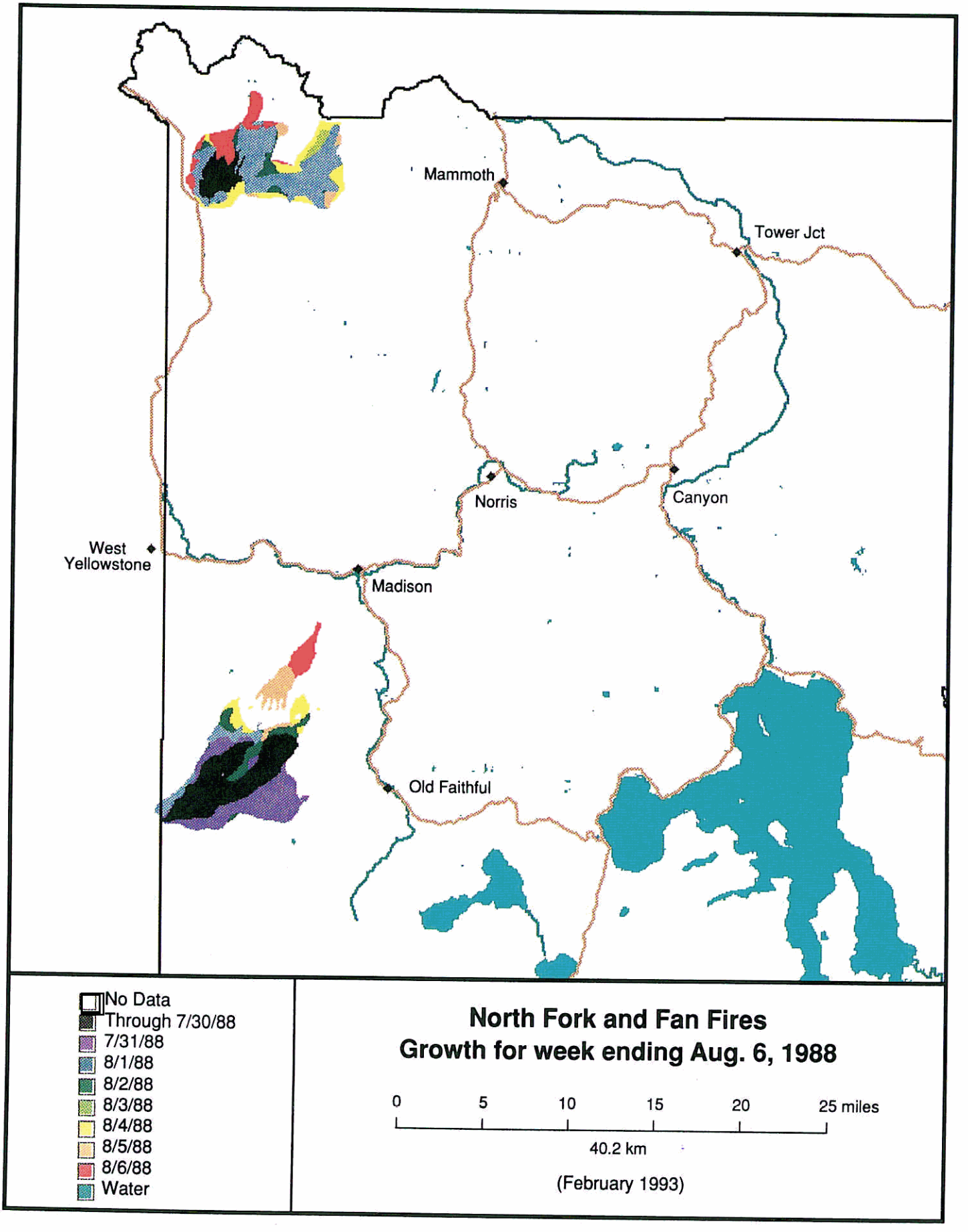

Mammoth
Fan Fire: 6/25/88
Tower Jct
Norris
Canyon
West Yellowstone
Madison
Old Faithful
No Data
Through 6/25/88
6/26/88
6/27/88
6/28/88
6/29/88
6/30/88
7/1/88
7/2/88
Water
North Fork and Fan Fires
Growth for week ending July 2, 1988
0 5 10 15 20 25 miles
40.2 km
(February 1993)

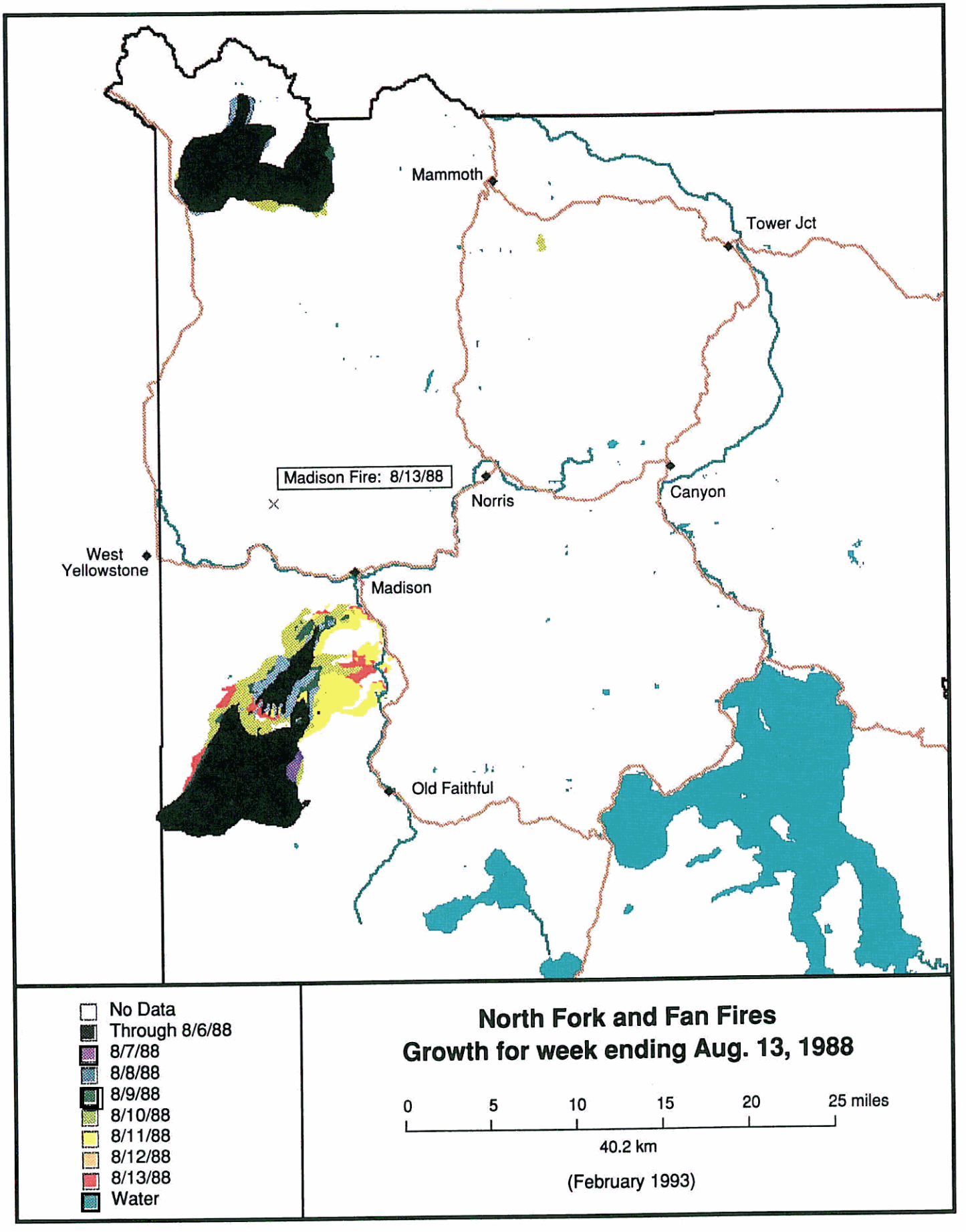

Mammoth
Tower Jct
Lava Fire: 7/5/88
Norris
Canyon
West Yellowstone
Madison
Old Faithful
No Data
Through 7/2/88
7/3/88
7/4/88
7/5/88
7/6/88
7/7/88
7/8/88
7/9/88
Water
North Fork and Fan Fires
Growth for week ending July 9, 1988
0 5 10 15 20 25 miles
40.2 km
(February 1993)

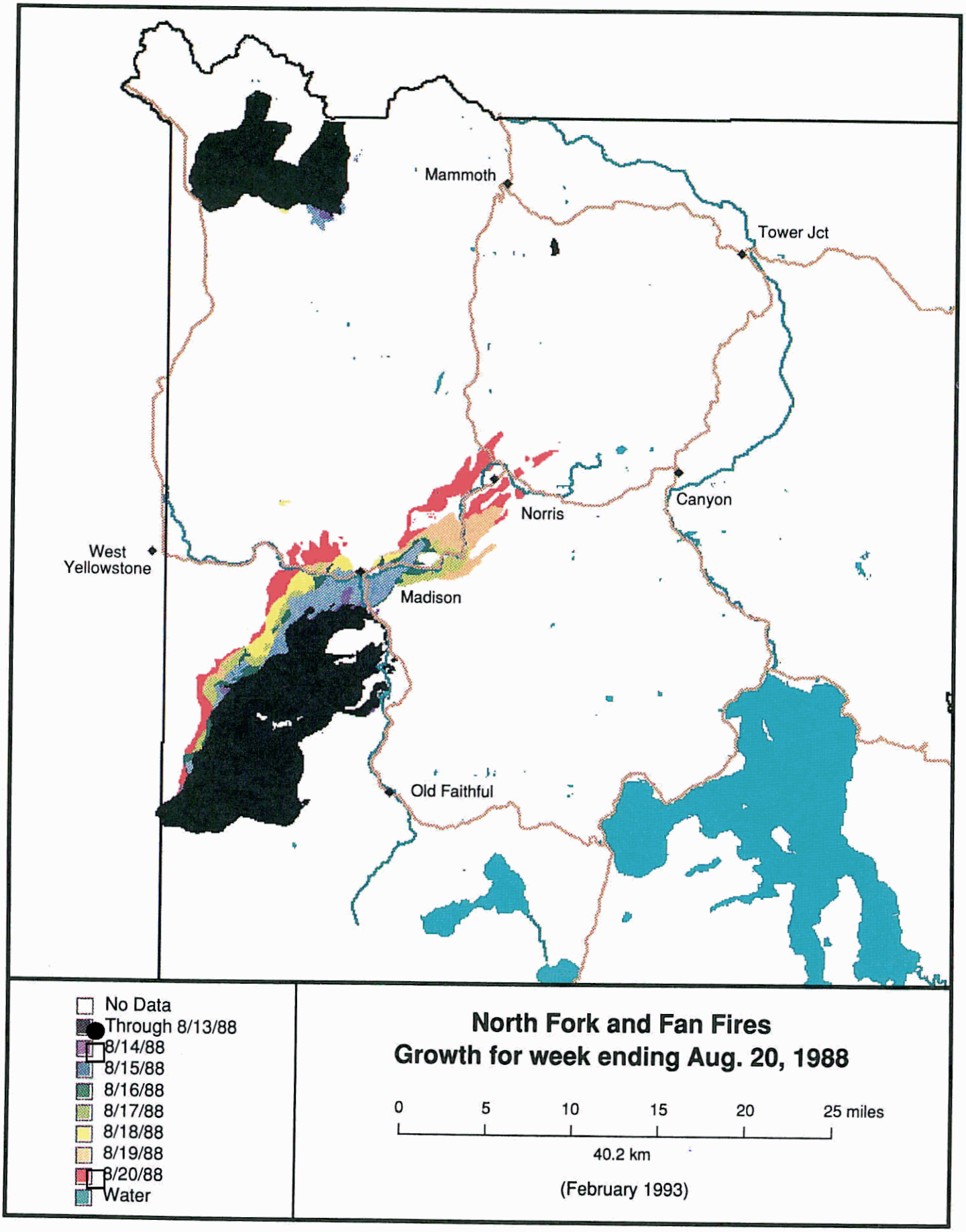

Mammoth
Tower Jct
Norris
Canyon
West
Yellowstone
Madison
Old Faithful
No Data
Through 7/9/88
7/10/88
7/11/88
7/12/88
7/13/88
7/14/88
7/15/88
7/16/88
Water
North Fork and Fan Fires
Growth for week ending July 16, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

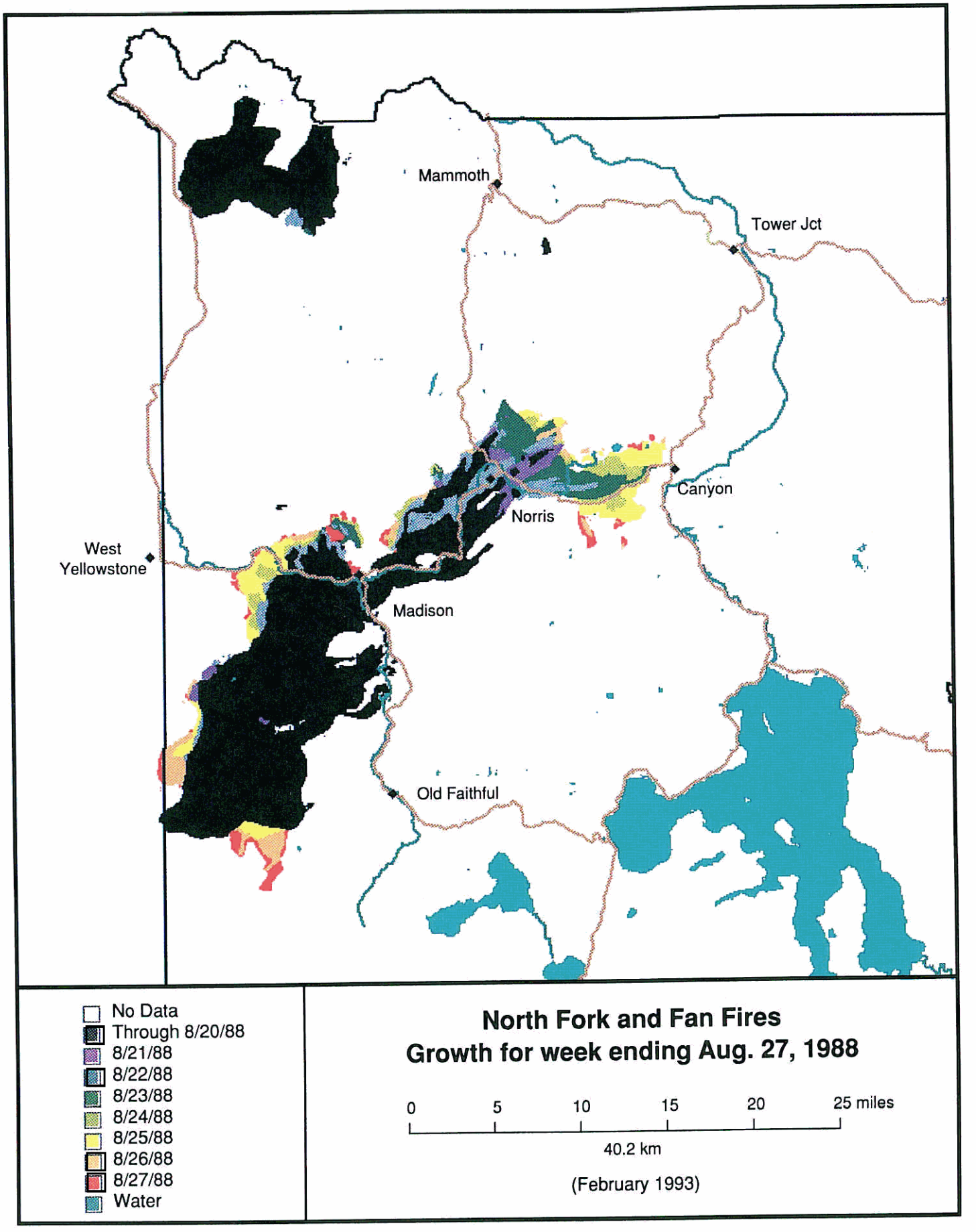

Mammoth
Tower Jct
Norris
Canyon
West Yellowstone
Madison
Old Faithful
North Fork Fire: 7/22/88
No Data
Through 7/16/88
7/17/88
7/18/88
7/19/88
7/20/88
7/21/88
7/22/88
7/23/88
Water
North Fork and Fan Fires
Growth for week ending July 23, 1988
0 5 10 15 20 25 miles
40.2 km
(February 1993)

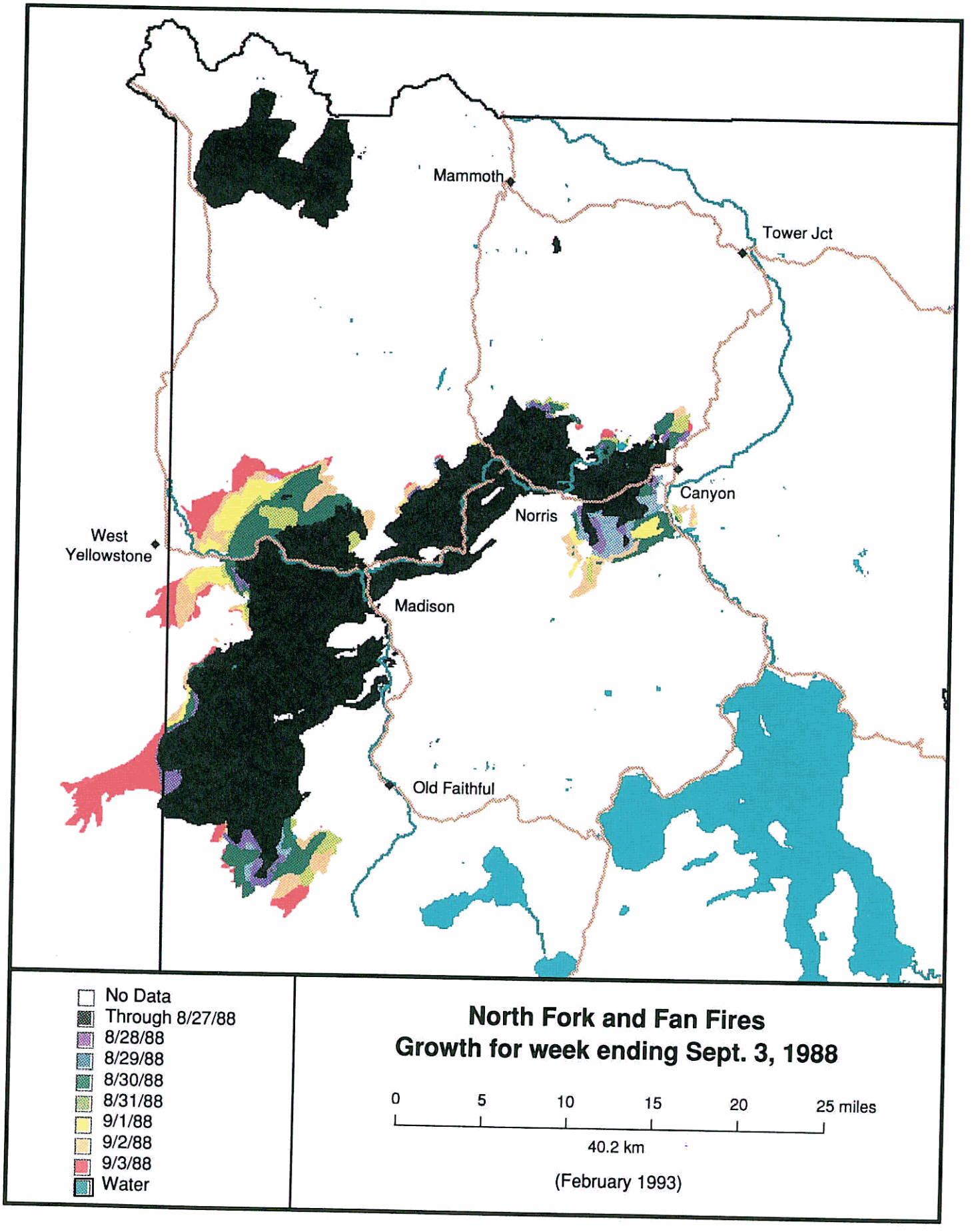

Mammoth
Tower Jct
Norris
Canyon
West Yellowstone
Madison
Old Faithful
No Data
Through 7/23/88
7/24/88
7/25/88
7/26/88
7/27/88
7/28/88
7/29/88
7/30/88
Water
North Fork and Fan Fires
Growth for week ending July 30, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

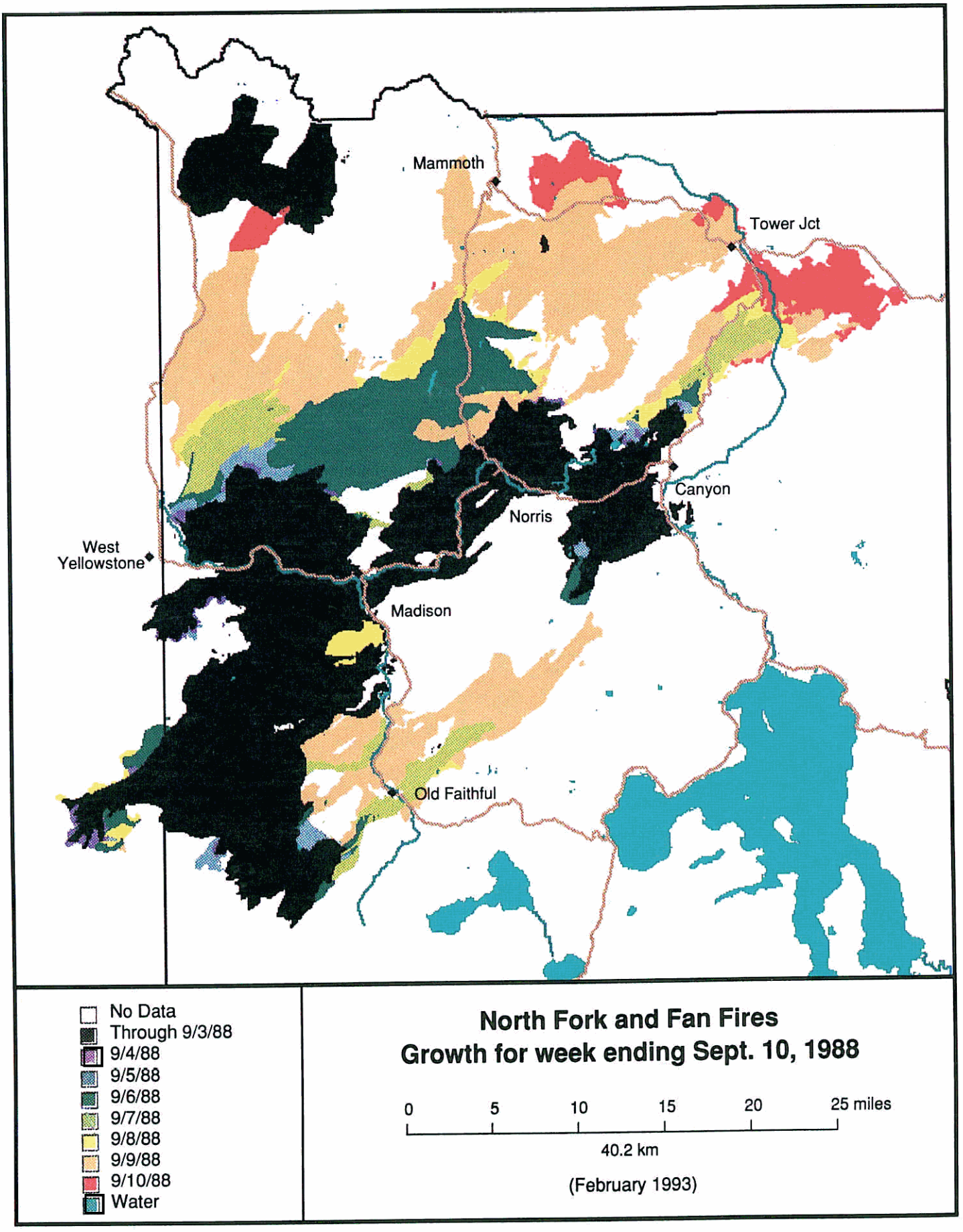

Mammoth
Tower Jct
Norris
Canyon
West Yellowstone
Madison
Old Faithful
No Data
Through 7/30/88
7/31/88
8/1/88
8/2/88
8/3/88
8/4/88
8/5/88
8/6/88
Water
North Fork and Fan Fires
Growth for week ending Aug. 6, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

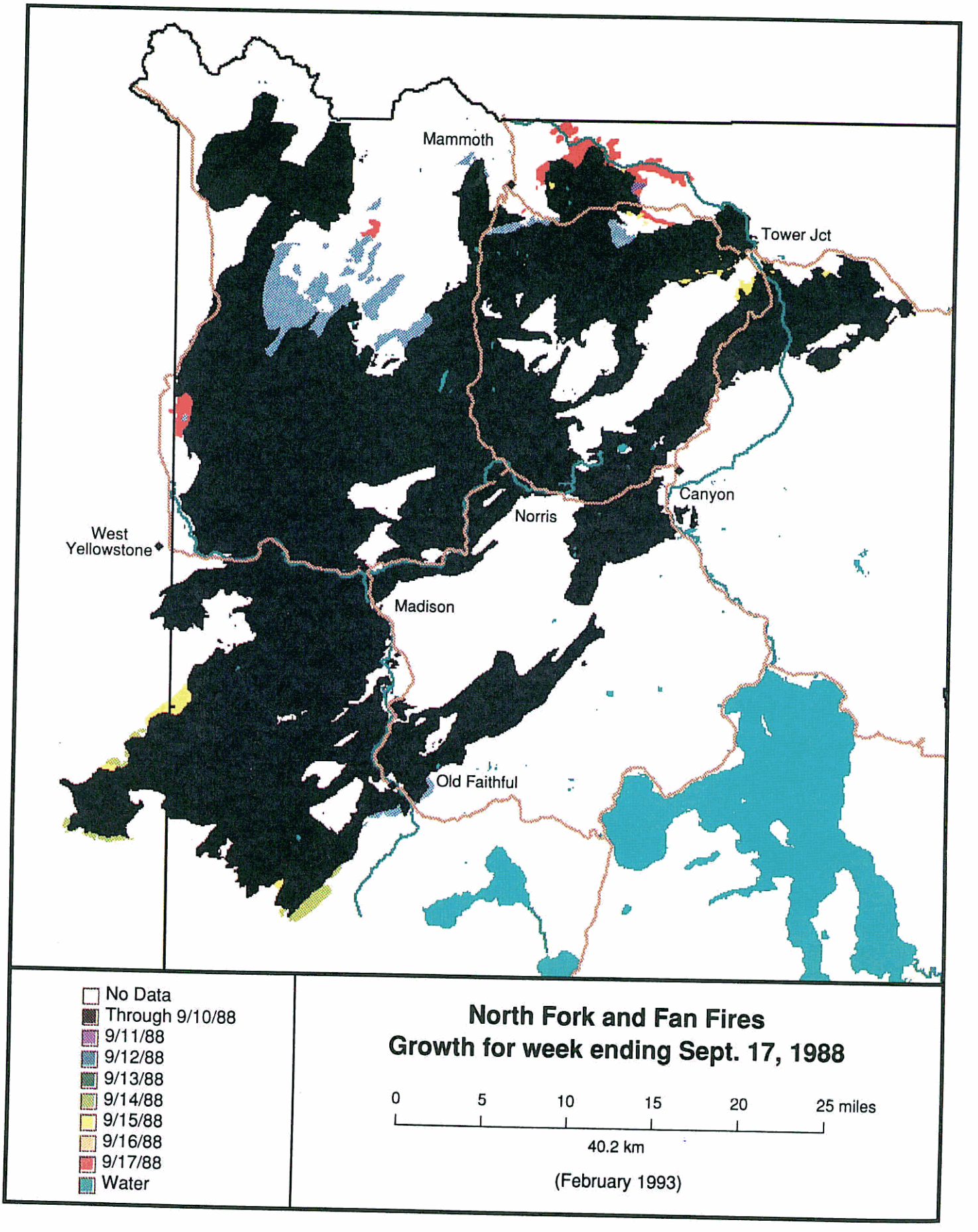

Mammoth
Tower Jct
Madison Fire: 8/13/88
Norris
Canyon
West Yellowstone
Madison
Old Faithful
No Data
Through 8/6/88
8/7/88
8/8/88
8/9/88
8/10/88
8/11/88
8/12/88
8/13/88
Water
North Fork and Fan Fires
Growth for week ending Aug. 13, 1988
0 5 10 15 20 25 miles
40.2 km
(February 1993)

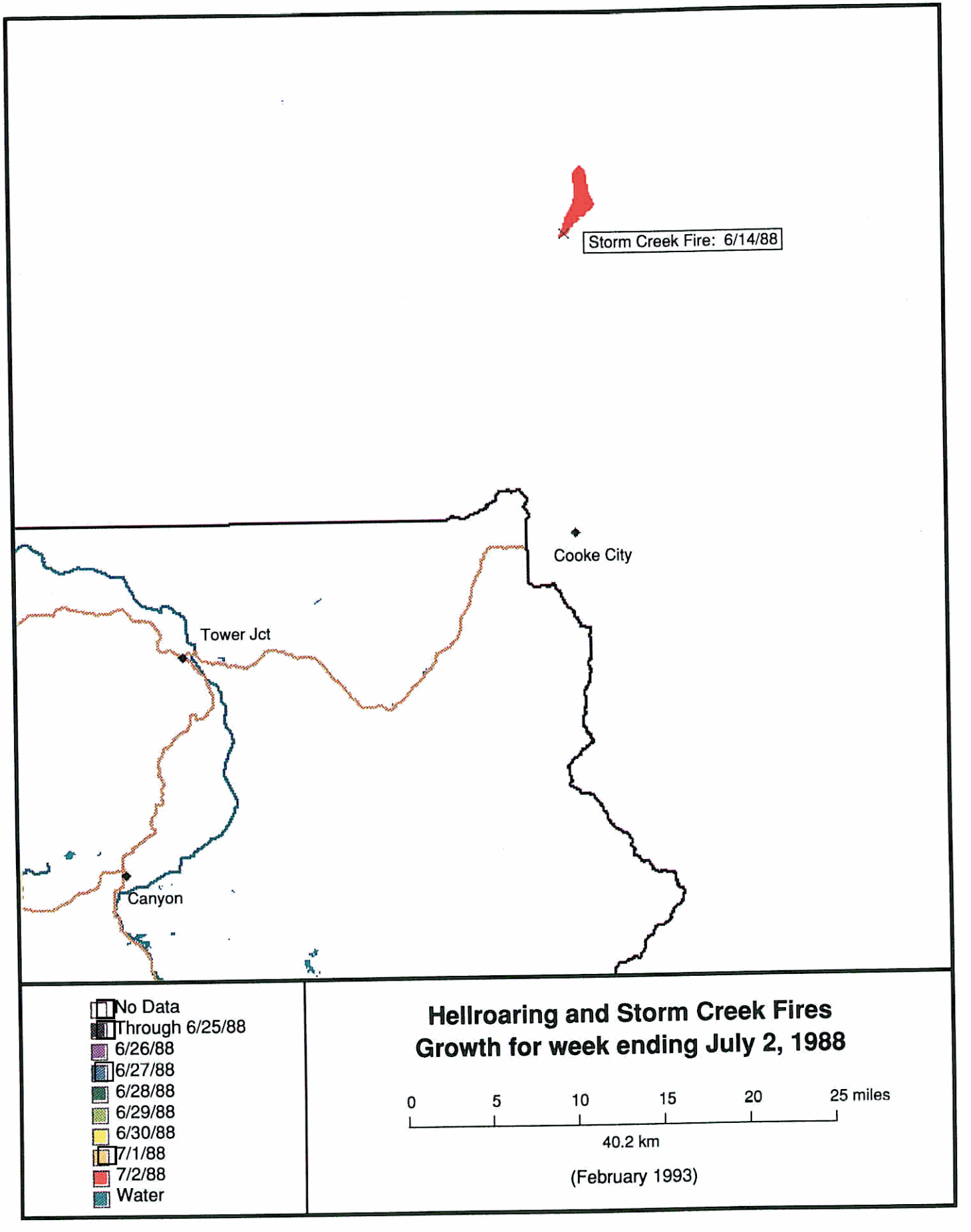

Mammoth
Tower Jct
Canyon
Norris
West Yellowstone
Madison
Old Faithful
No Data
Through 8/13/88
8/14/88
8/15/88
8/16/88
8/17/88
8/18/88
8/19/88
8/20/88
Water
North Fork and Fan Fires
Growth for week ending Aug. 20, 1988
0 5 10 15 20 25 miles
40.2 km
(February 1993)

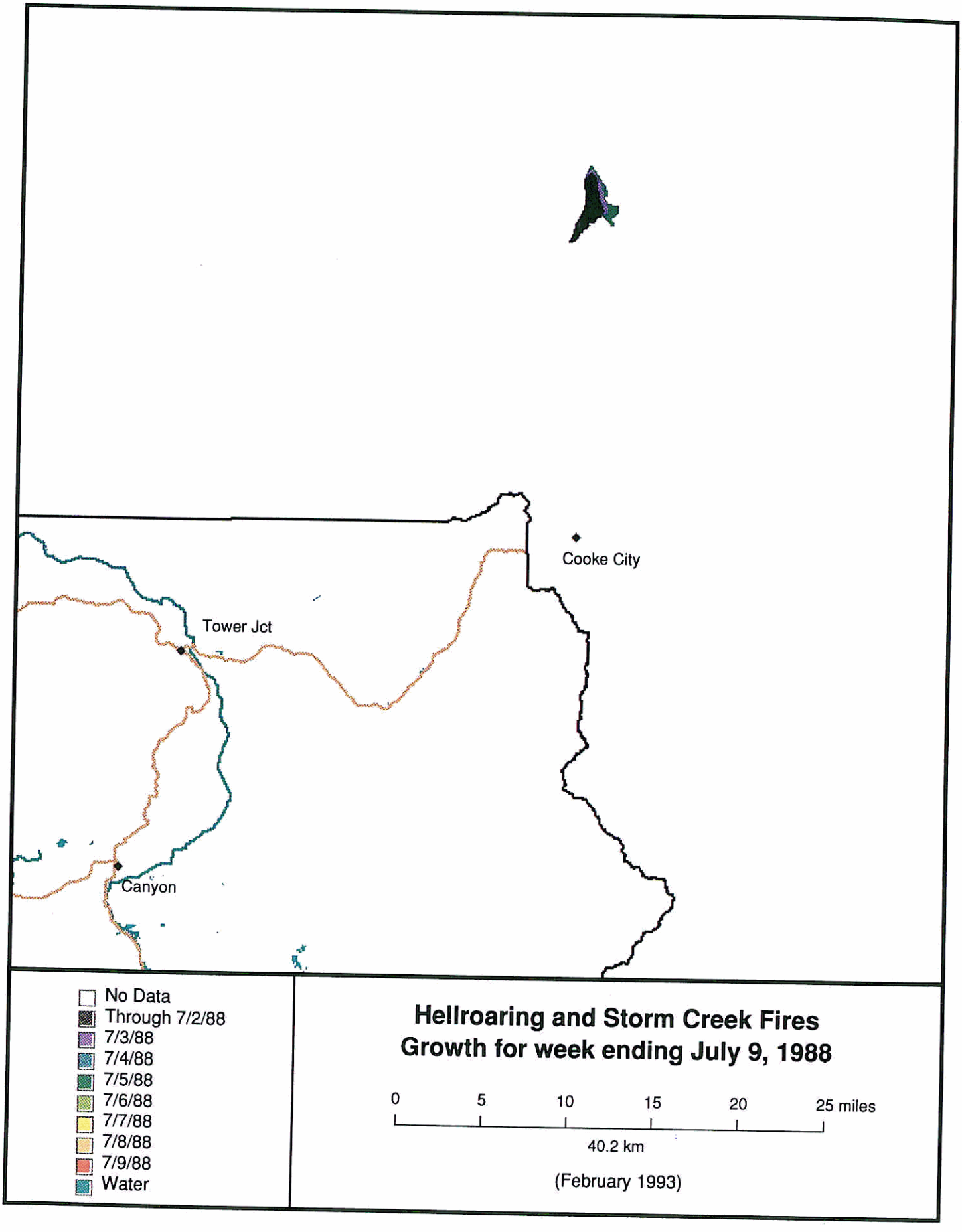

Mammoth
Tower Jct
Canyon
Norris
West
Yellowstone
Madison
Old Faithful
No Data
Through 8/20/88
8/21/88
8/22/88
8/23/88
8/24/88
8/25/88
8/26/88
8/27/88
Water
North Fork and Fan Fires
Growth for week ending Aug. 27, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

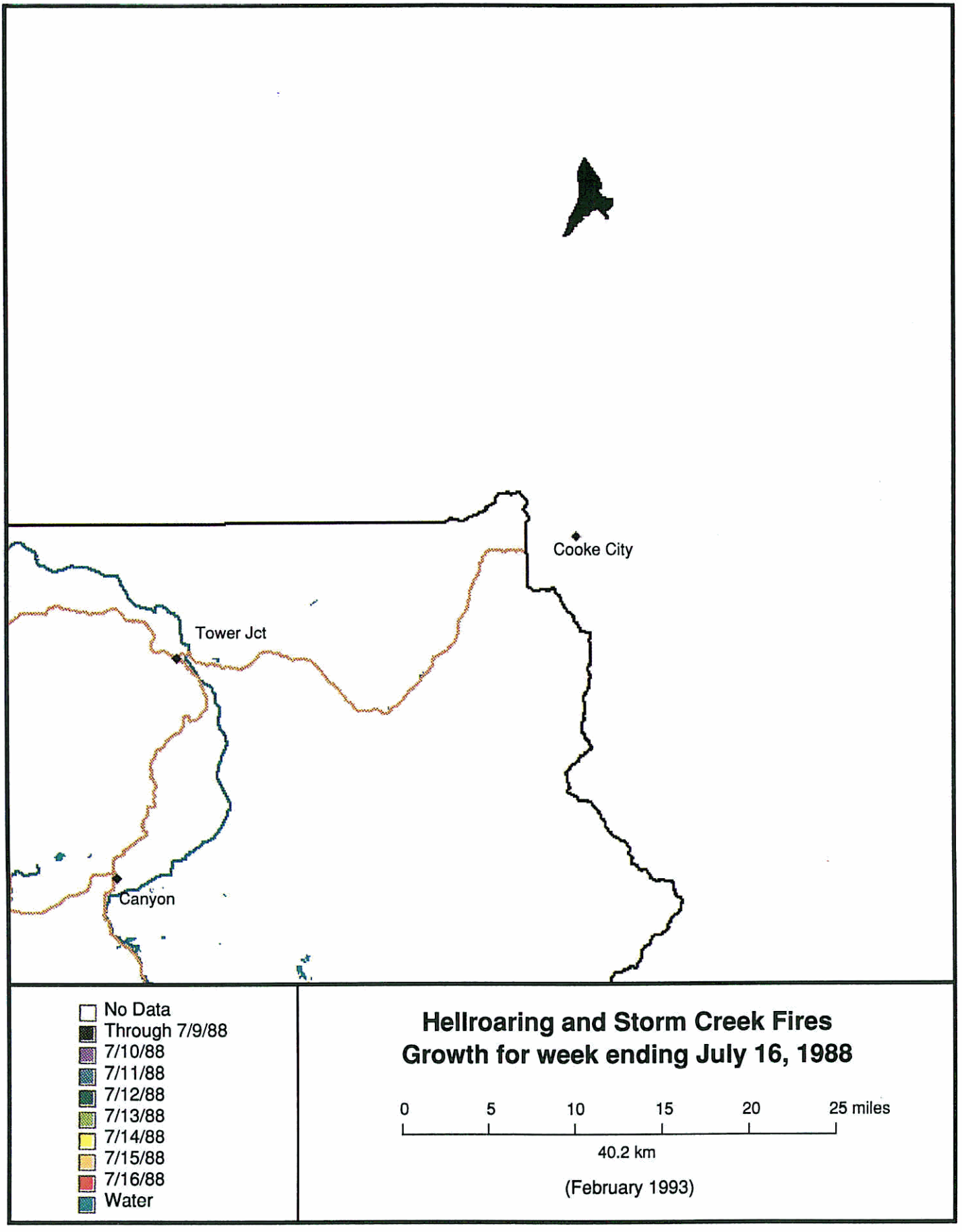

Mammoth
Tower Jct
Canyon
Norris
West
Yellowstone
Madison
Old Faithful
No Data
Through 8/27/88
8/28/88
8/29/88
8/30/88
8/31/88
9/1/88
9/2/88
9/3/88
Water
North Fork and Fan Fires
Growth for week ending Sept. 3, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

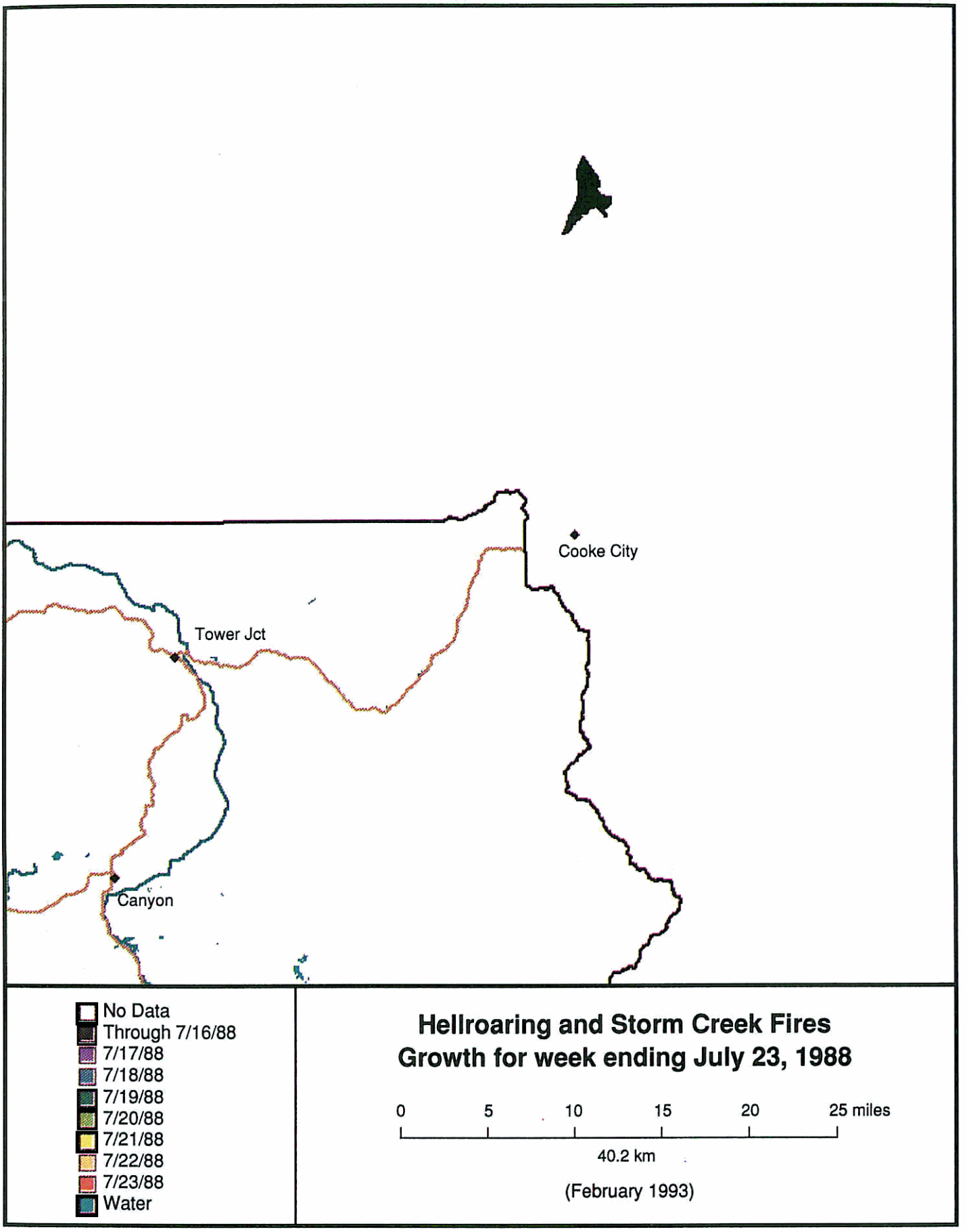

Mammoth
Tower Jct
Canyon
Norris
West Yellowstone
Madison
Old Faithful
No Data
Through 9/3/88
9/4/88
9/5/88
9/6/88
9/7/88
9/8/88
9/9/88
9/10/88
Water
North Fork and Fan Fires
Growth for week ending Sept. 10, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

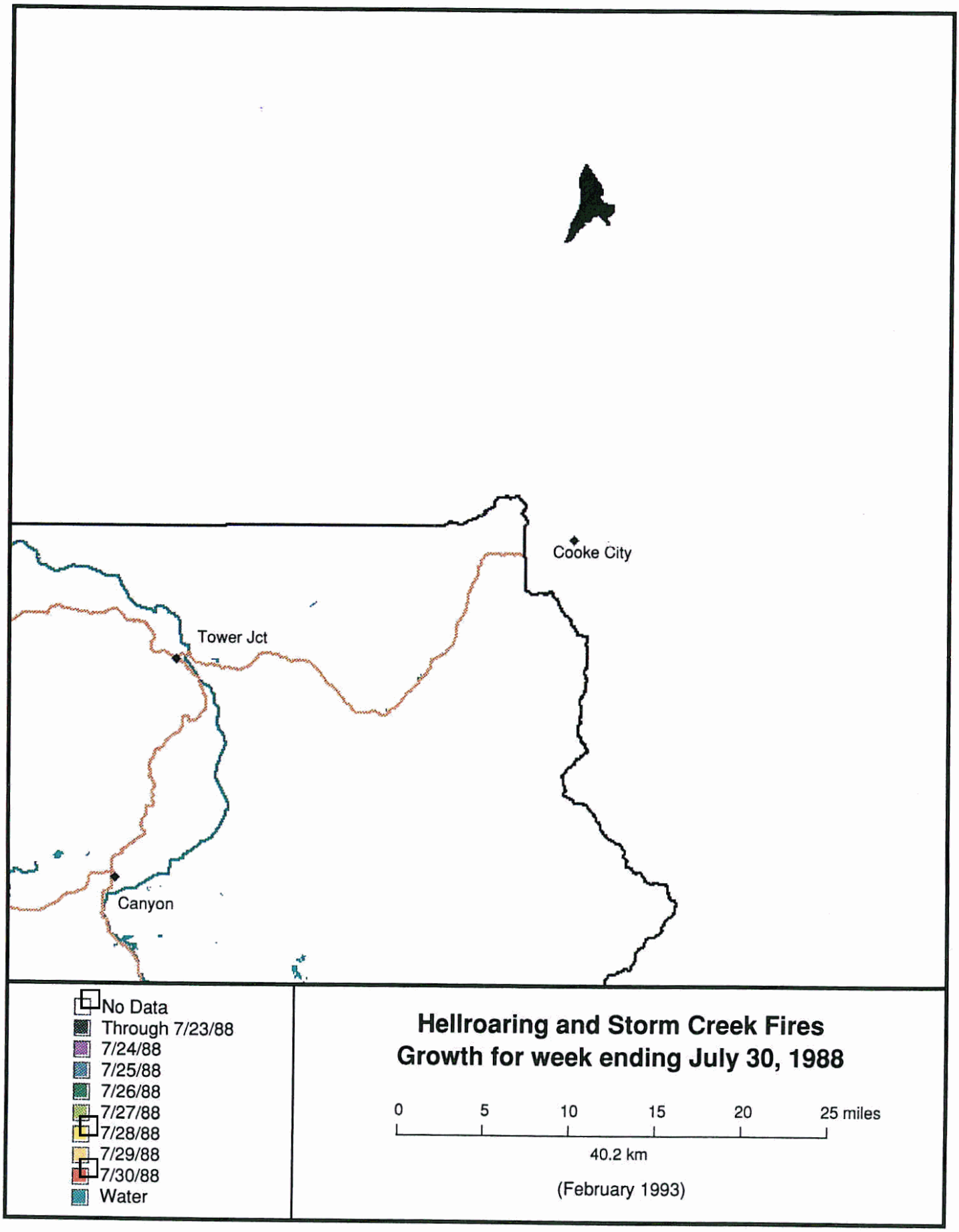

Mammoth
Tower Jct
Canyon
Norris
West Yellowstone
Madison
Old Faithful
No Data
Through 9/10/88
9/11/88
9/12/88
9/13/88
9/14/88
9/15/88
9/16/88
9/17/88
Water
North Fork and Fan Fires
Growth for week ending Sept. 17, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

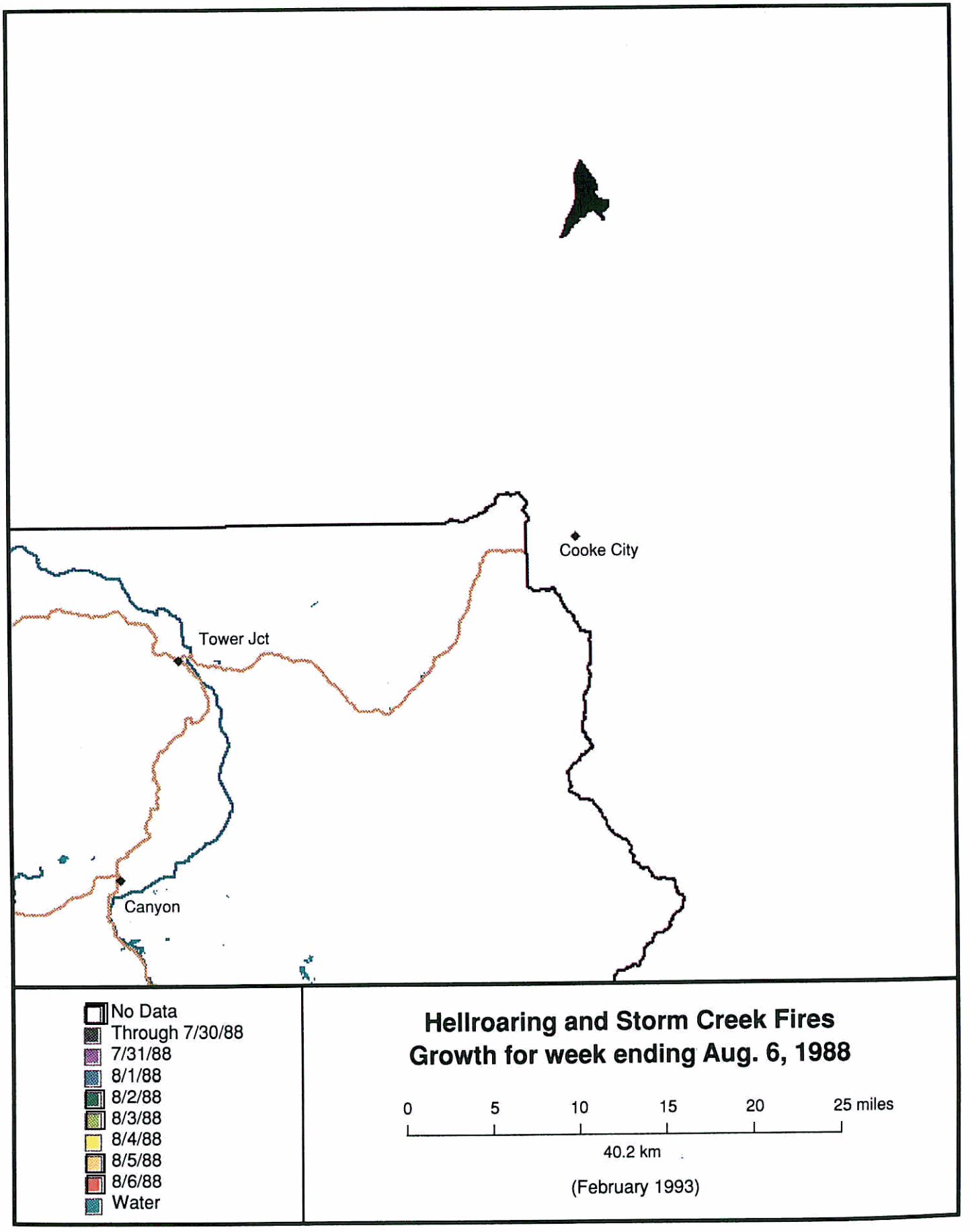

Storm Creek Fire: 6/14/88
Cooke City
Tower Jct
Canyon
No Data
Through 6/25/88
6/26/88
6/27/88
6/28/88
6/29/88
6/30/88
7/1/88
7/2/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending July 2, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

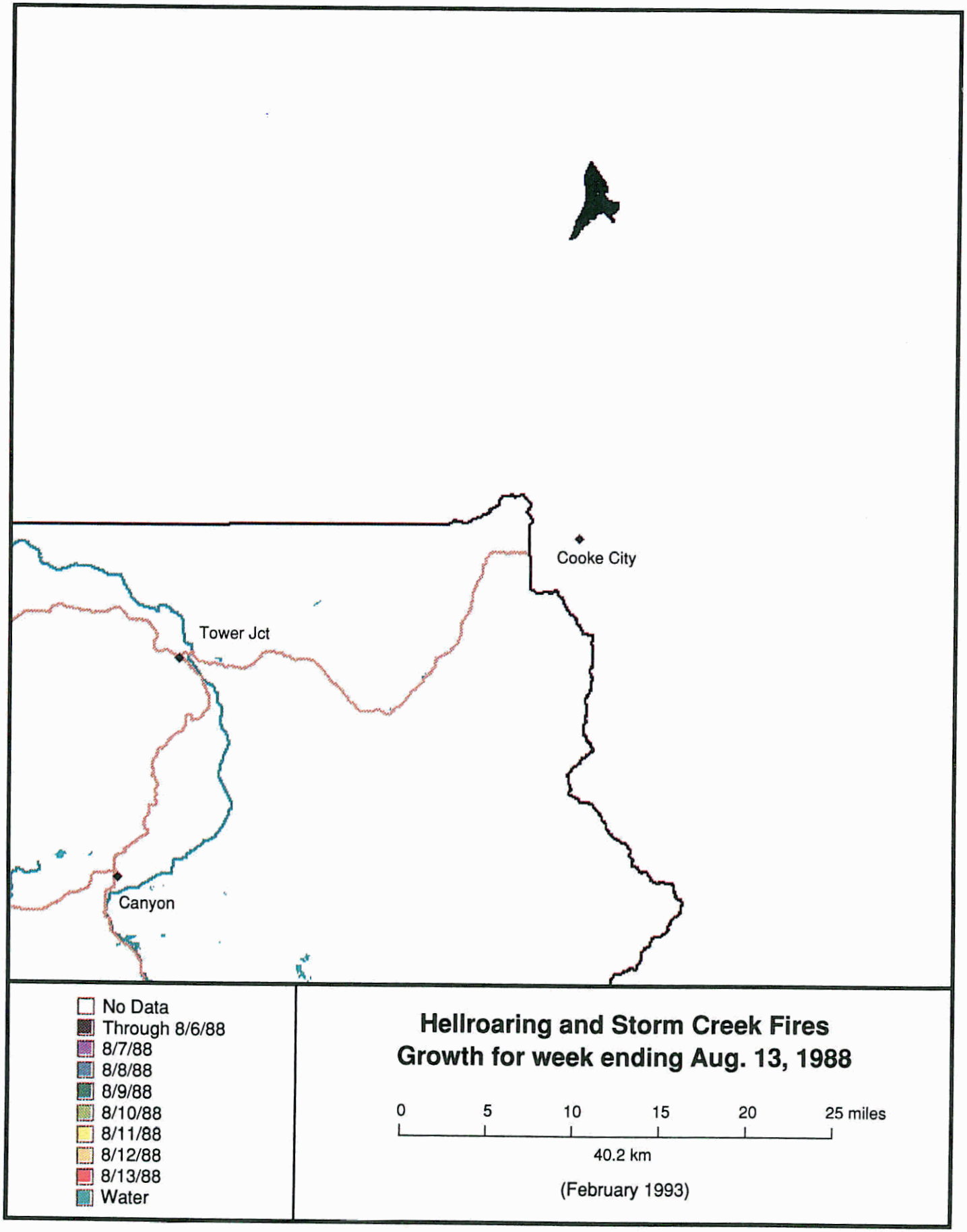

Cooke City
Tower Jct
Canyon
No Data
Through 7/2/88
7/3/88
7/4/88
7/5/88
7/6/88
7/7/88
7/8/88
7/9/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending July 9, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

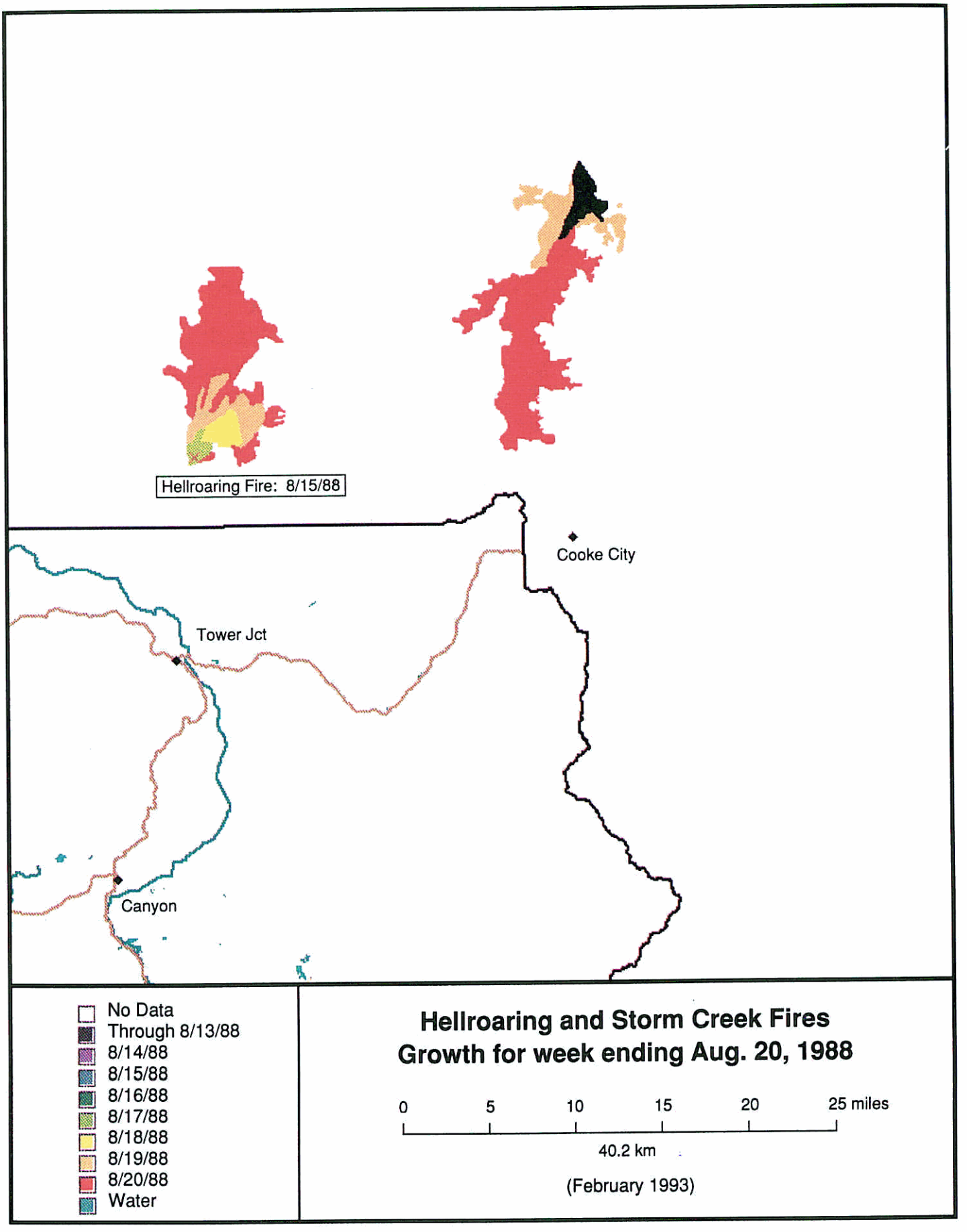

Cooke City
Tower Jct
Canyon
No Data
Through 7/9/88
7/10/88
7/11/88
7/12/88
7/13/88
7/14/88
7/15/88
7/16/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending July 16, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

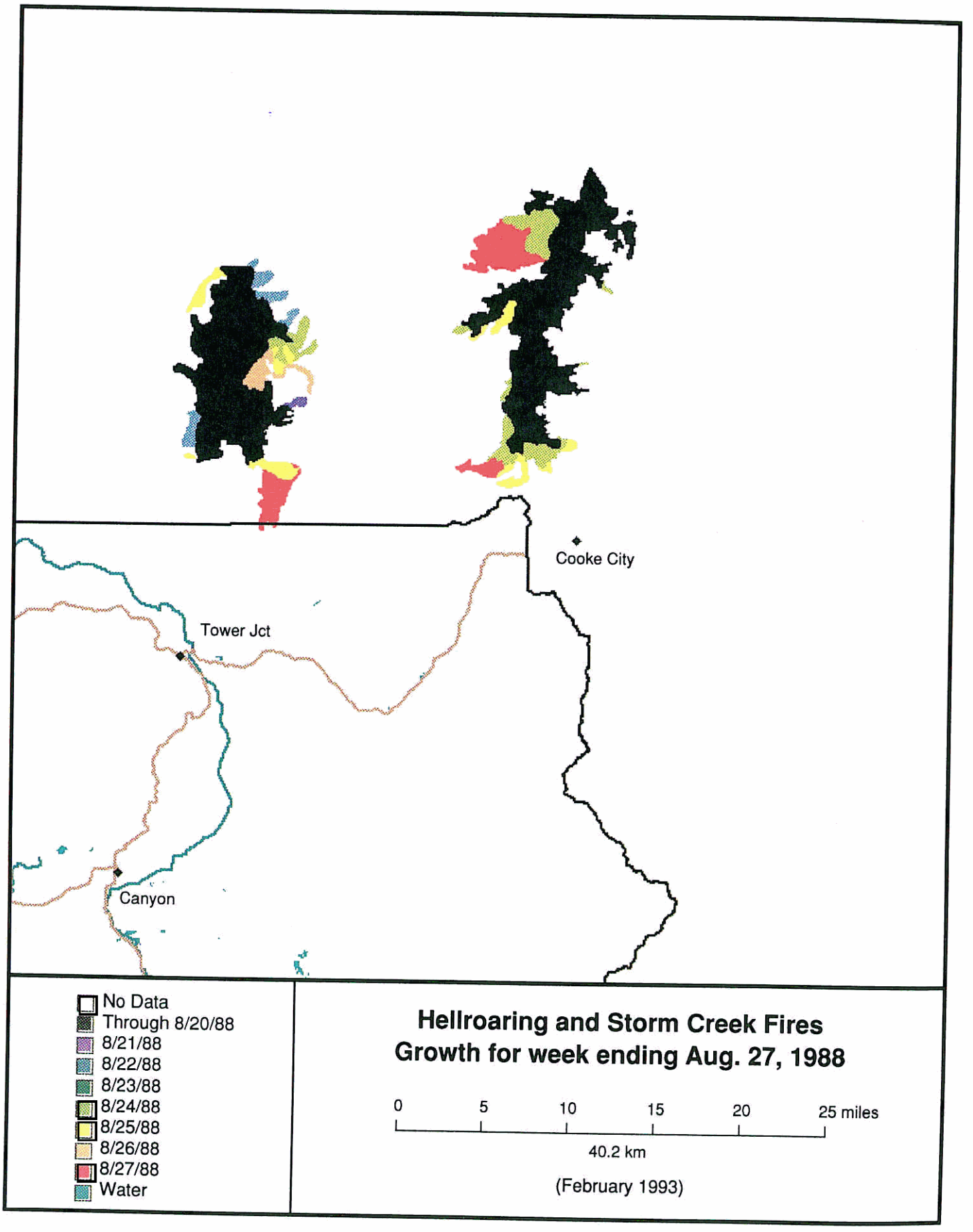

Cooke City
Tower Jct
Canyon
No Data
Through 7/16/88
7/17/88
7/18/88
7/19/88
7/20/88
7/21/88
7/22/88
7/23/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending July 23, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

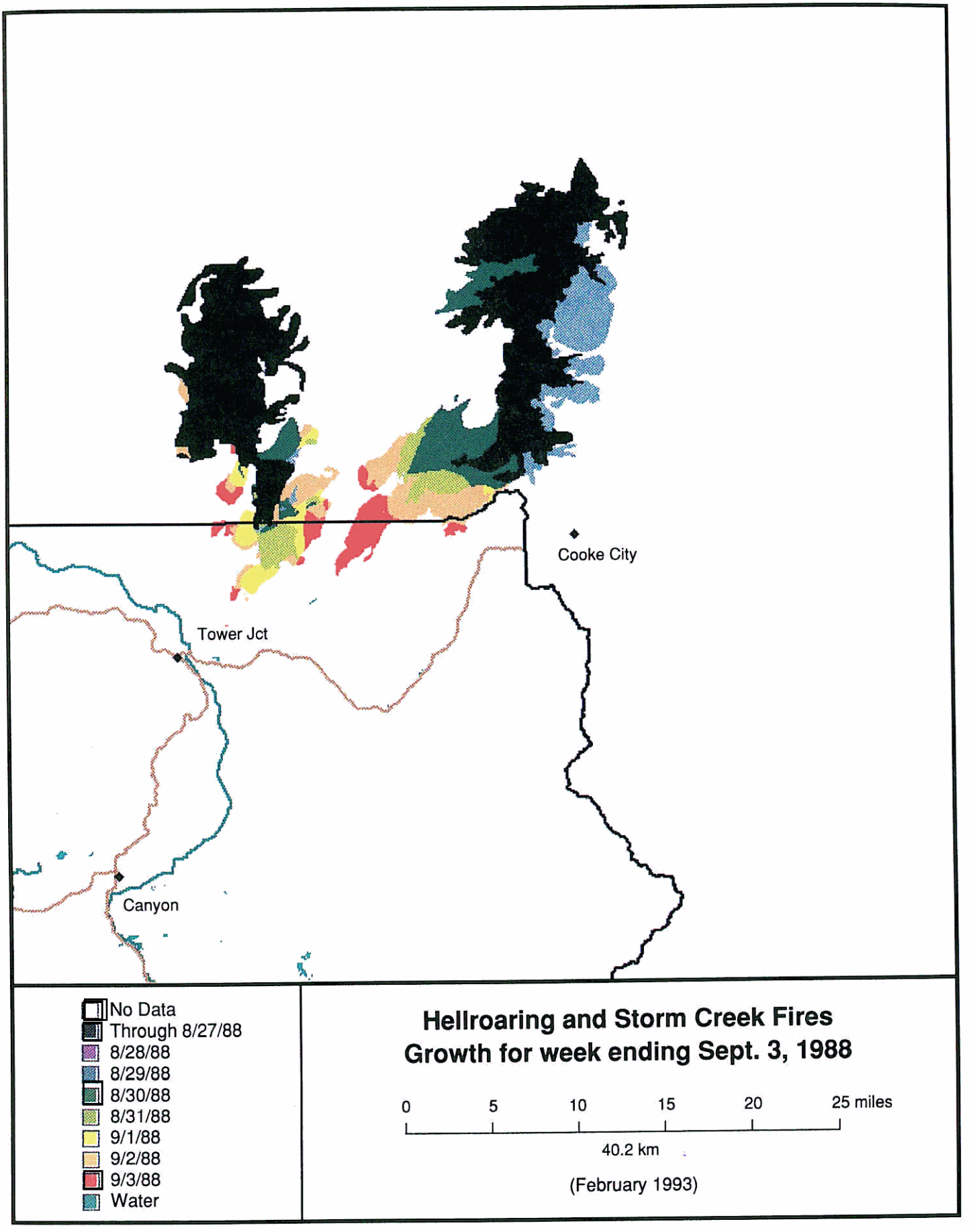

Cooke City
Tower Jct
Canyon
No Data
Through 7/23/88
7/24/88
7/25/88
7/26/88
7/27/88
7/28/88
7/29/88
7/30/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending July 30, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

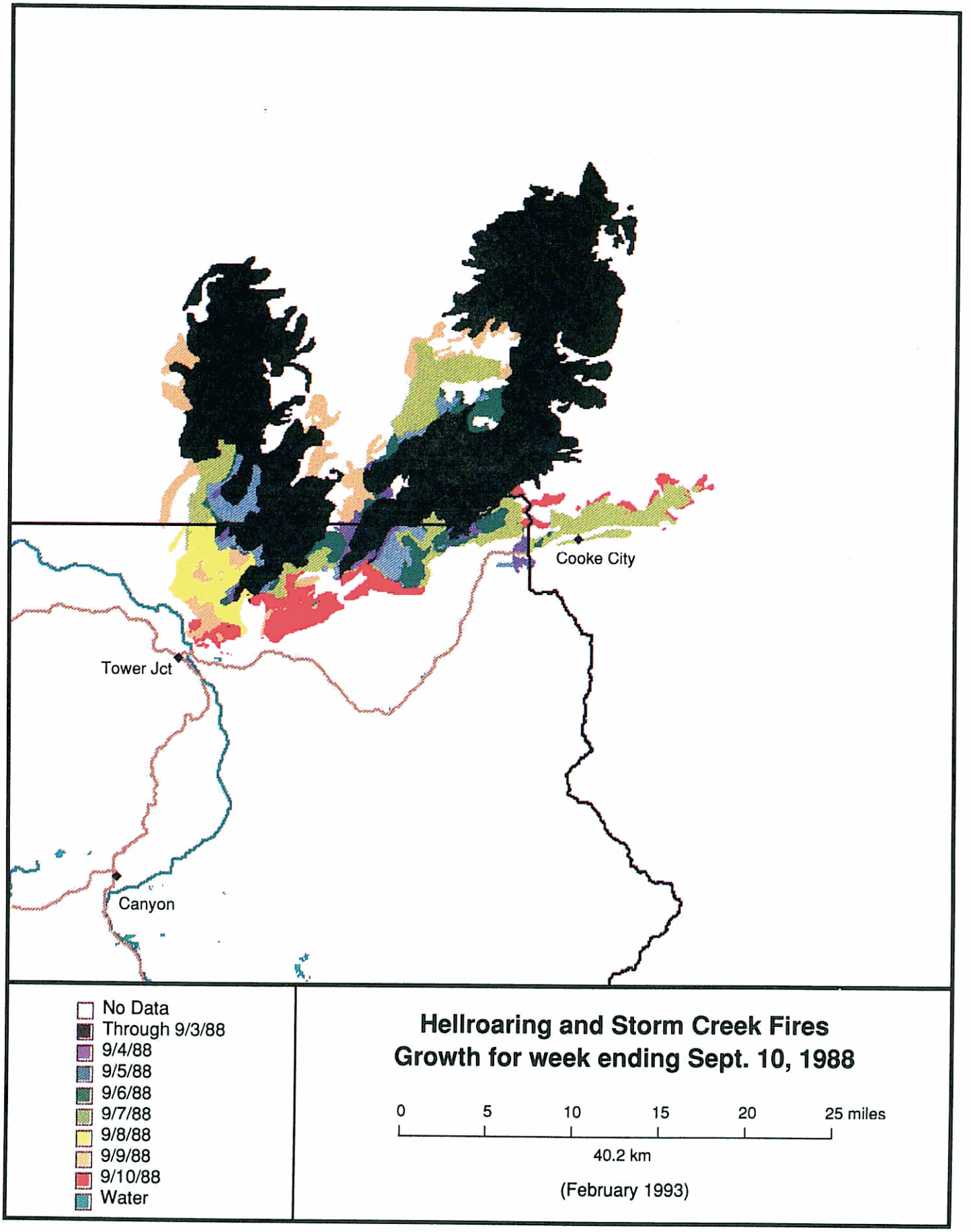

Cooke City
Tower Jct
Canyon
No Data
Through 7/30/88
7/31/88
8/1/88
8/2/88
8/3/88
8/4/88
8/5/88
8/6/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending Aug. 6, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

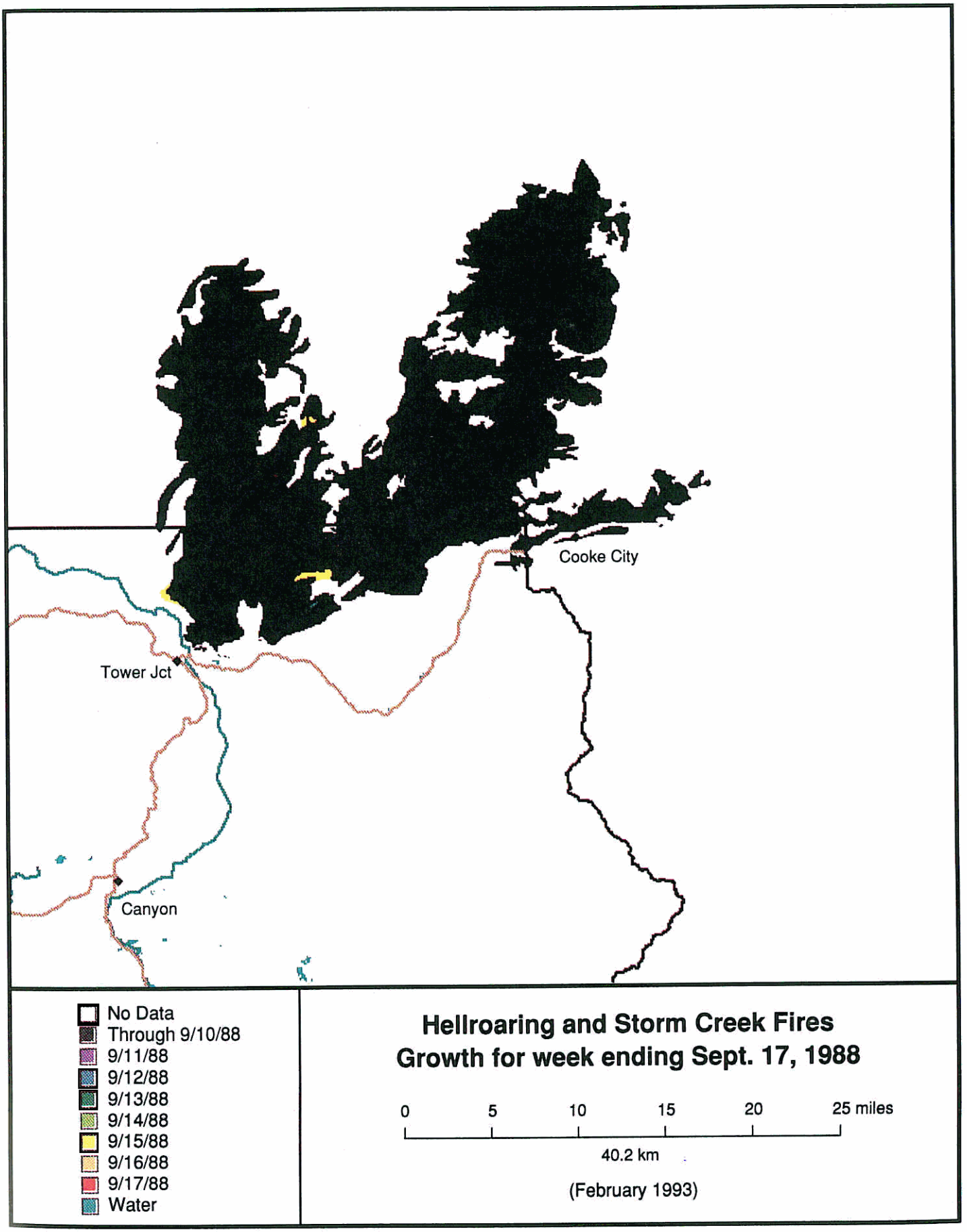

Cooke City
Tower Jct
Canyon
No Data
Through 8/6/88
8/7/88
8/8/88
8/9/88
8/10/88
8/11/88
8/12/88
8/13/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending Aug. 13, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

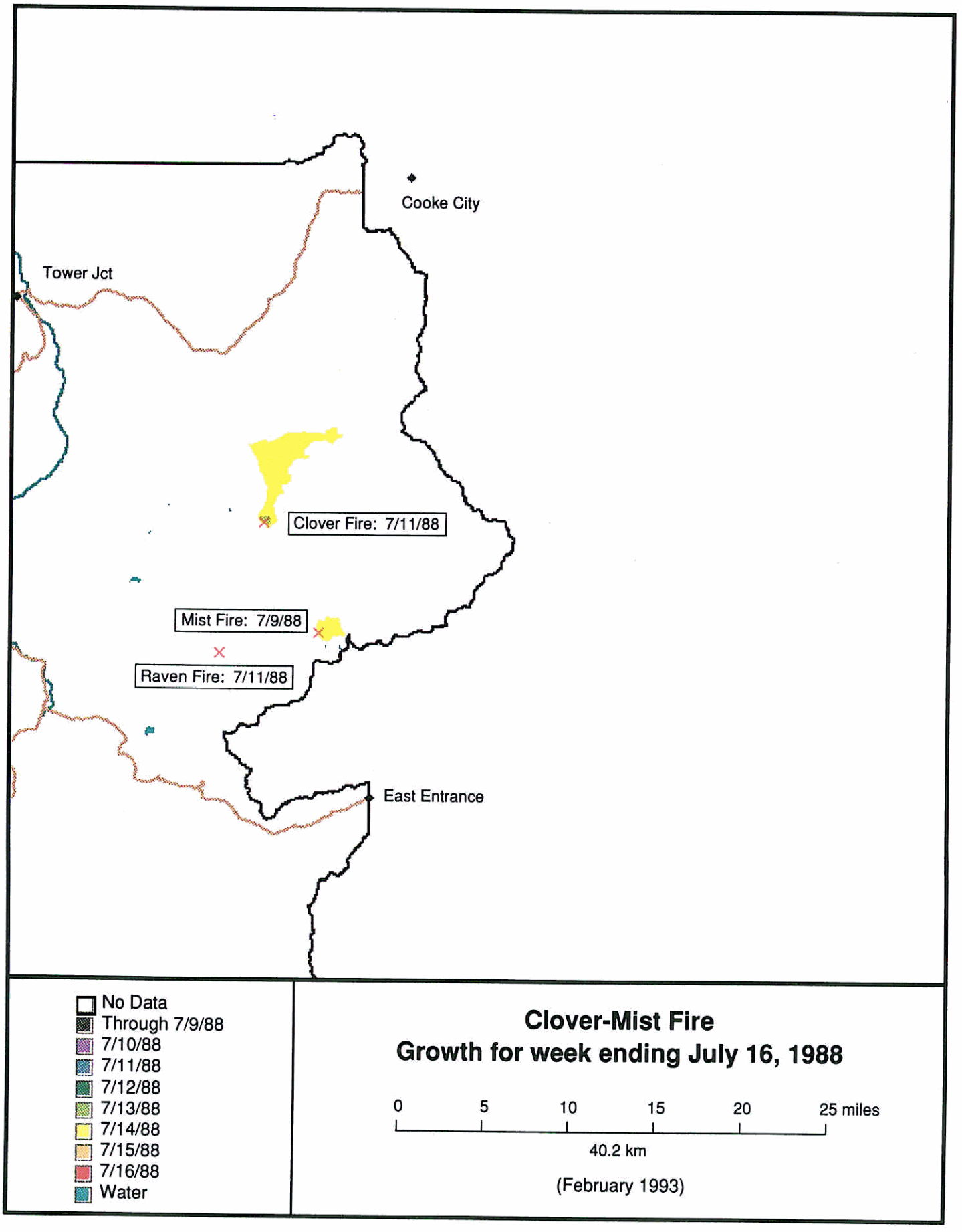

Hellroaring Fire: 8/15/88
Cooke City
Tower Jct
Canyon
No Data
Through 8/13/88
8/14/88
8/15/88
8/16/88
8/17/88
8/18/88
8/19/88
8/20/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending Aug. 20, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

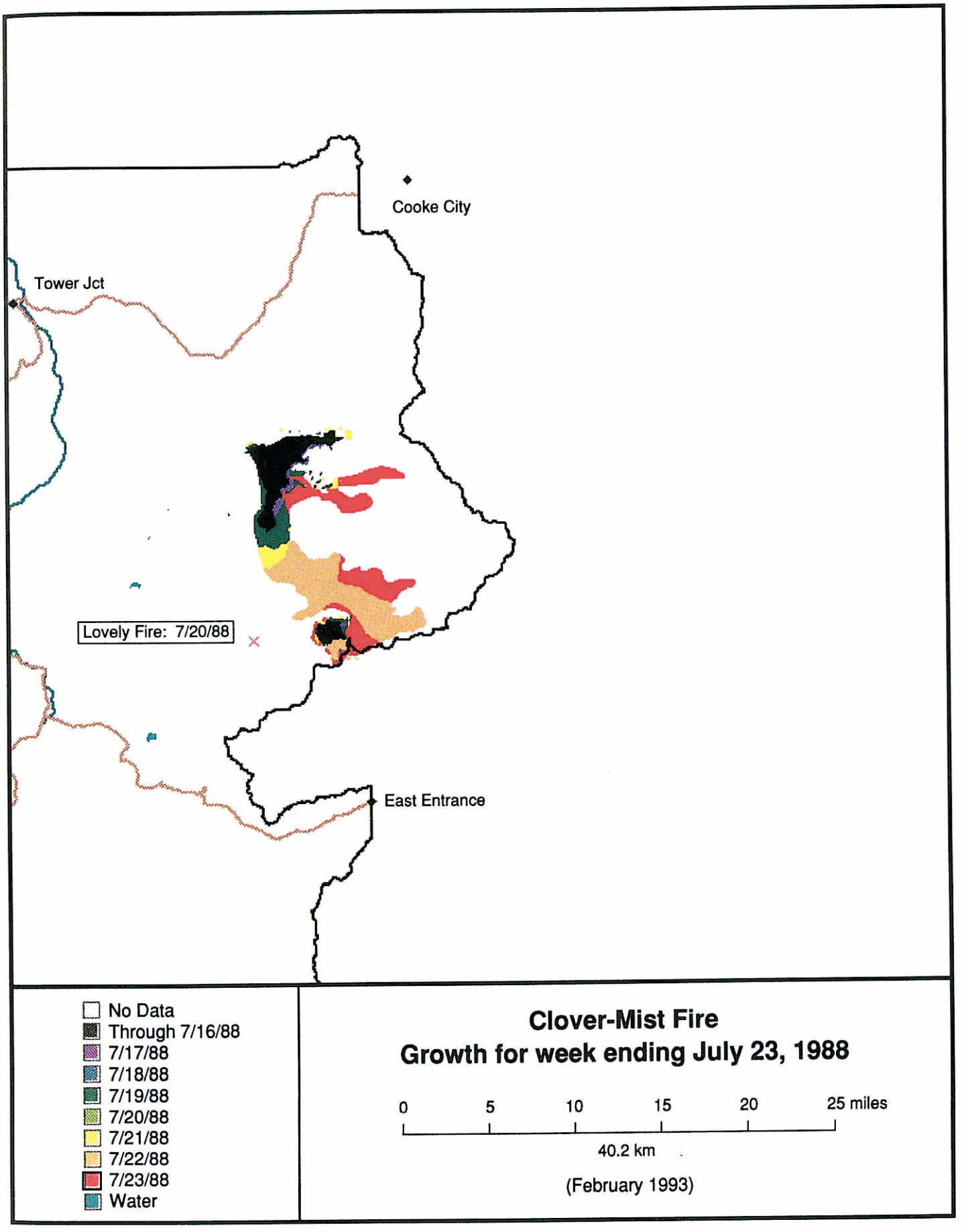

Cooke City
Tower Jct
Canyon
No Data
Through 8/20/88
8/21/88
8/22/88
8/23/88
8/24/88
8/25/88
8/26/88
8/27/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending Aug. 27, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

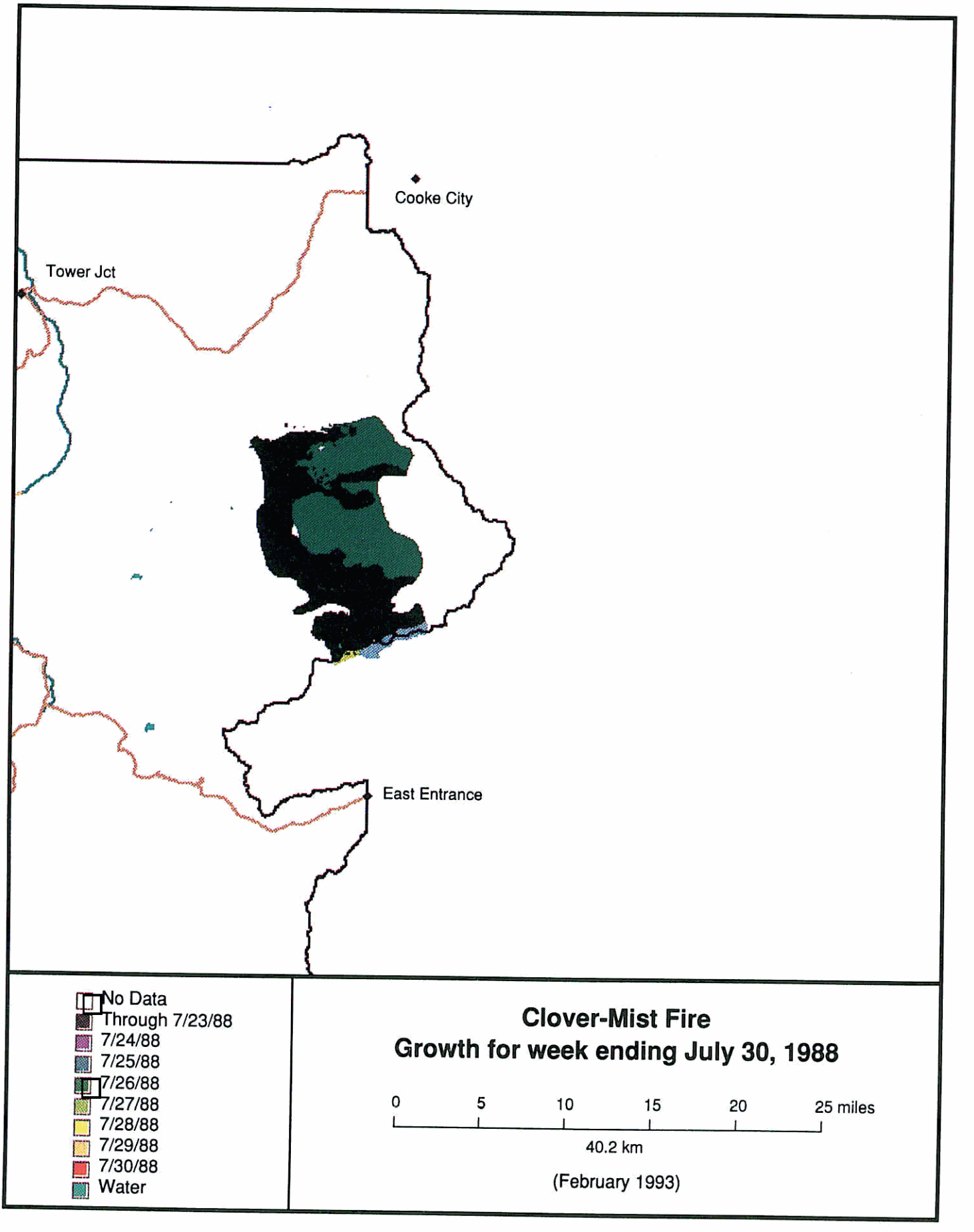

Cooke City
Tower Jct
Canyon
No Data
Through 8/27/88
8/28/88
8/29/88
8/30/88
8/31/88
9/1/88
9/2/88
9/3/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending Sept. 3, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

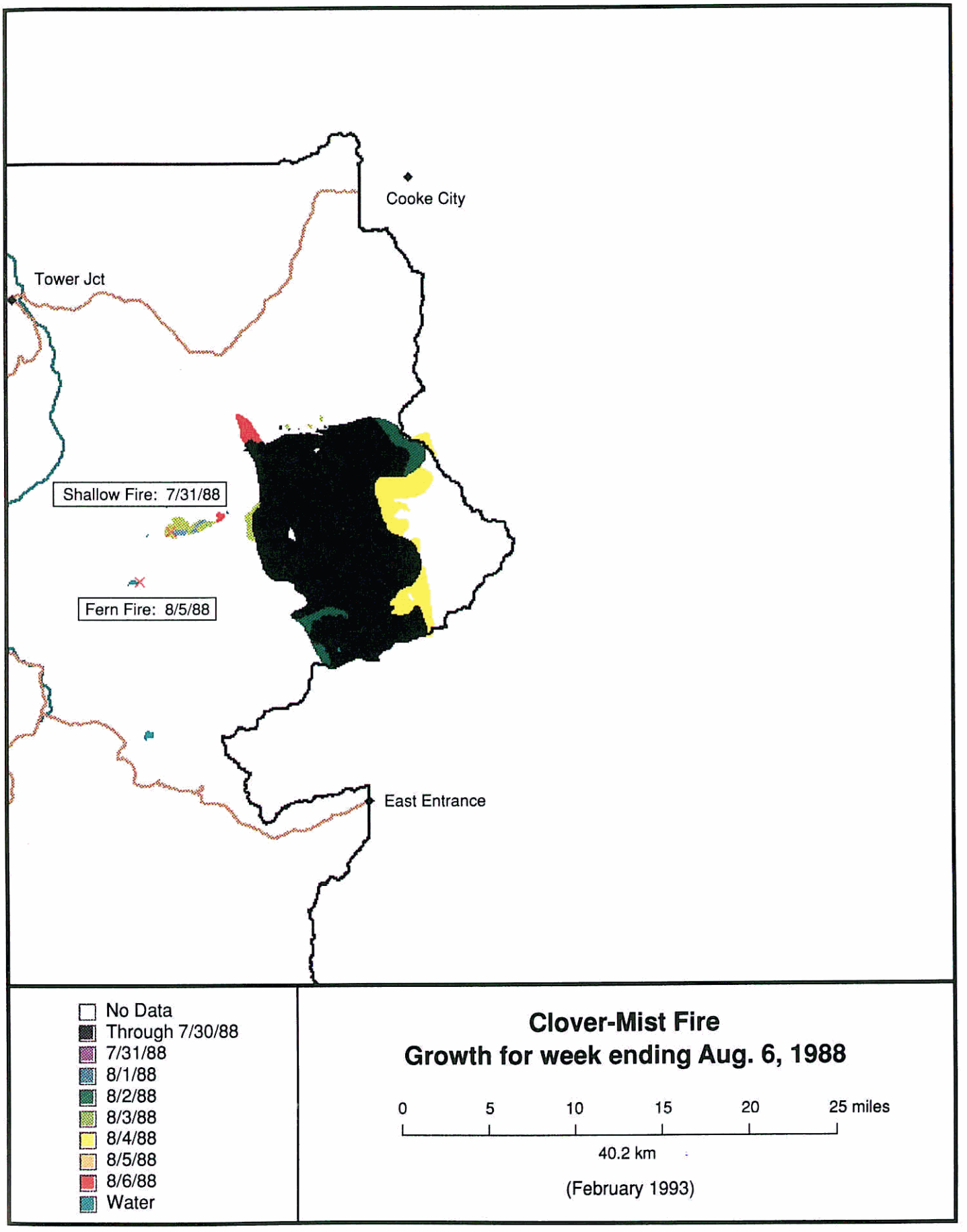

Cooke City
Tower Jct
Canyon
No Data
Through 9/3/88
9/4/88
9/5/88
9/6/88
9/7/88
9/8/88
9/9/88
9/10/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending Sept. 10, 1988
0 5 10 15 20 25 miles
40.2 km
(February 1993)

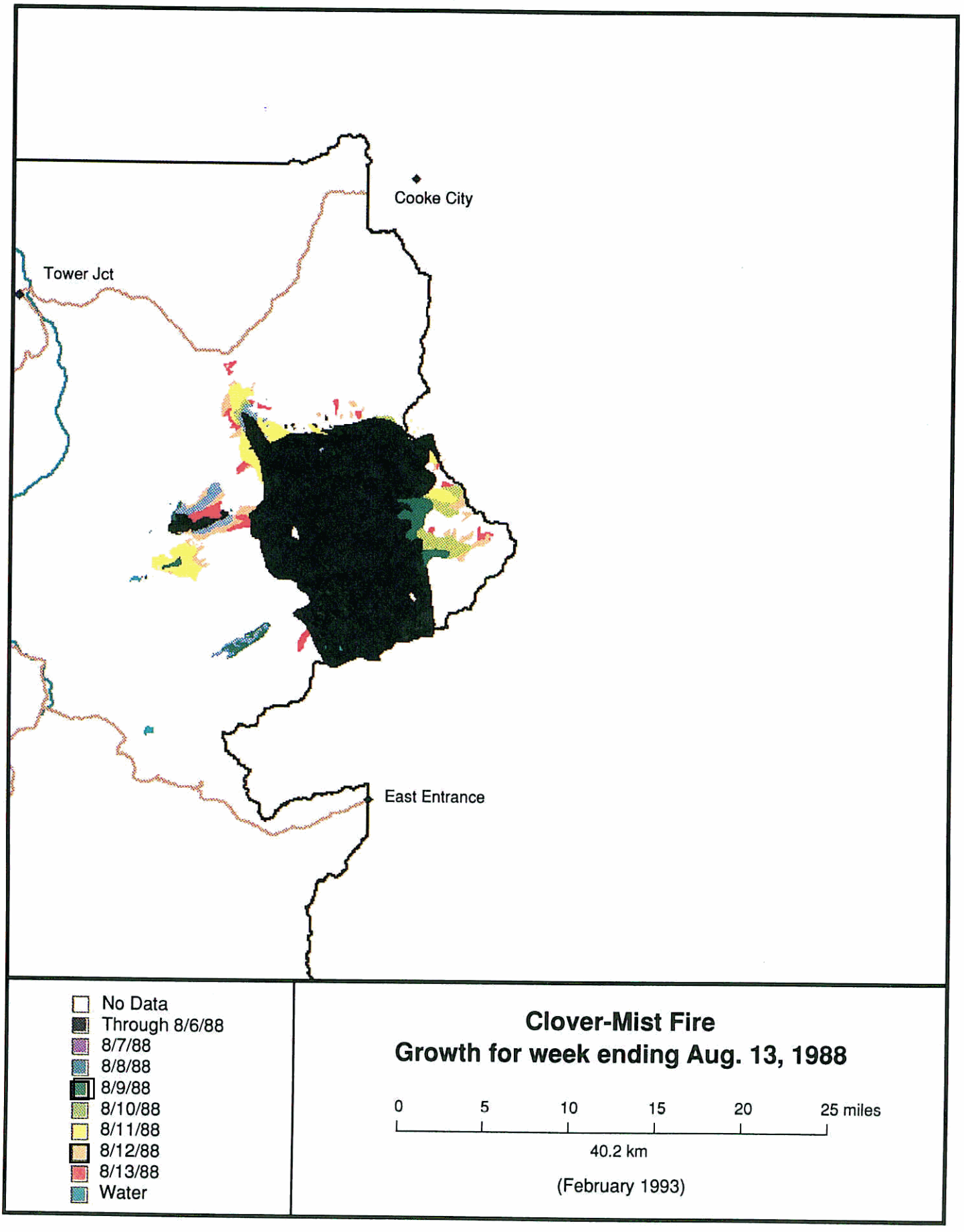

Cooke City
Tower Jct
Canyon
No Data
Through 9/10/88
9/11/88
9/12/88
9/13/88
9/14/88
9/15/88
9/16/88
9/17/88
Water
Hellroaring and Storm Creek Fires
Growth for week ending Sept. 17, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

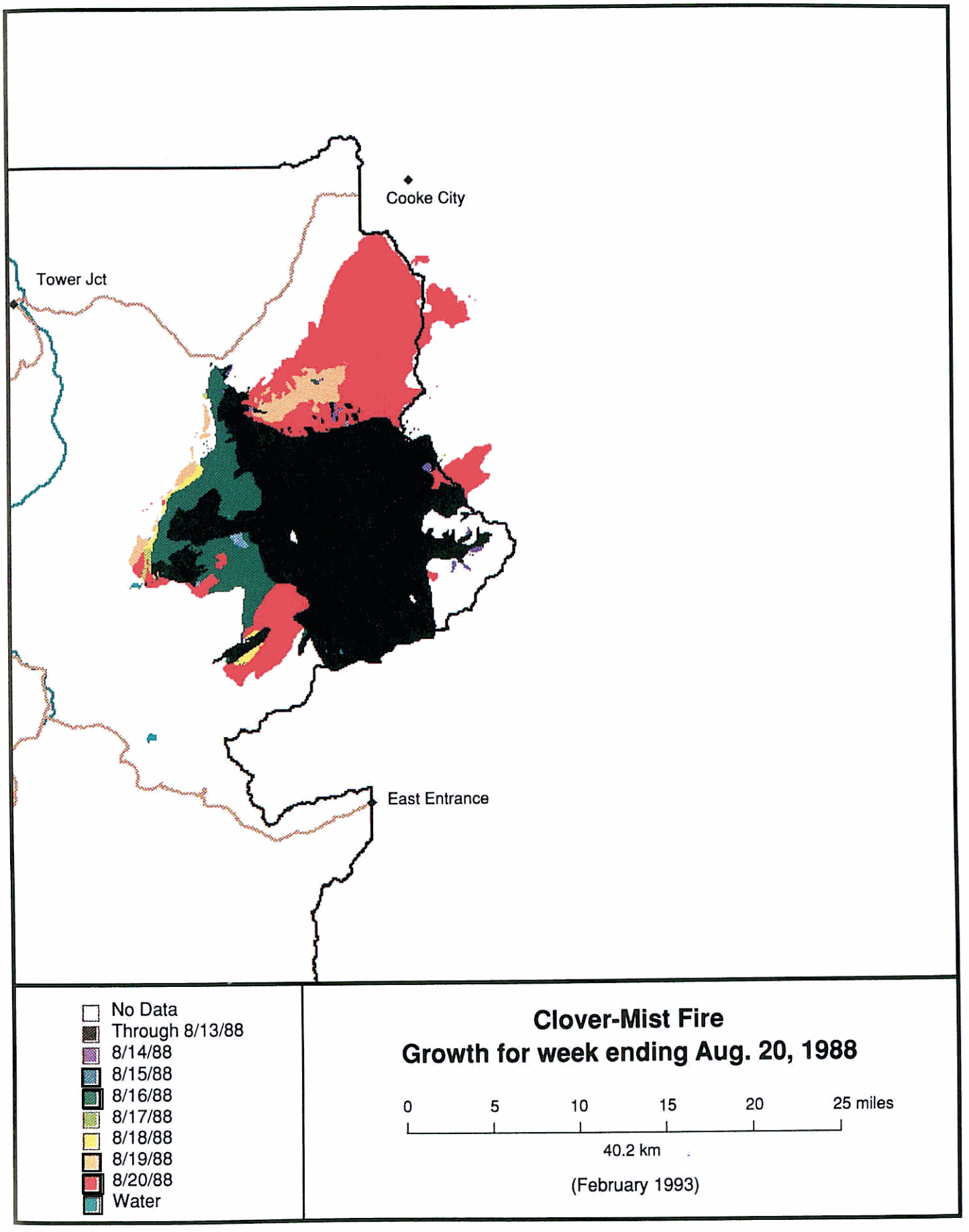

Cooke City
Tower Jct
Clover Fire: 7/11/88
Mist Fire: 7/9/88
Raven Fire: 7/11/88
East Entrance
No Data
Through 7/9/88
7/10/88
7/11/88
7/12/88
7/13/88
7/14/88
7/15/88
7/16/88
Water
Clover-Mist Fire
Growth for week ending July 16, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

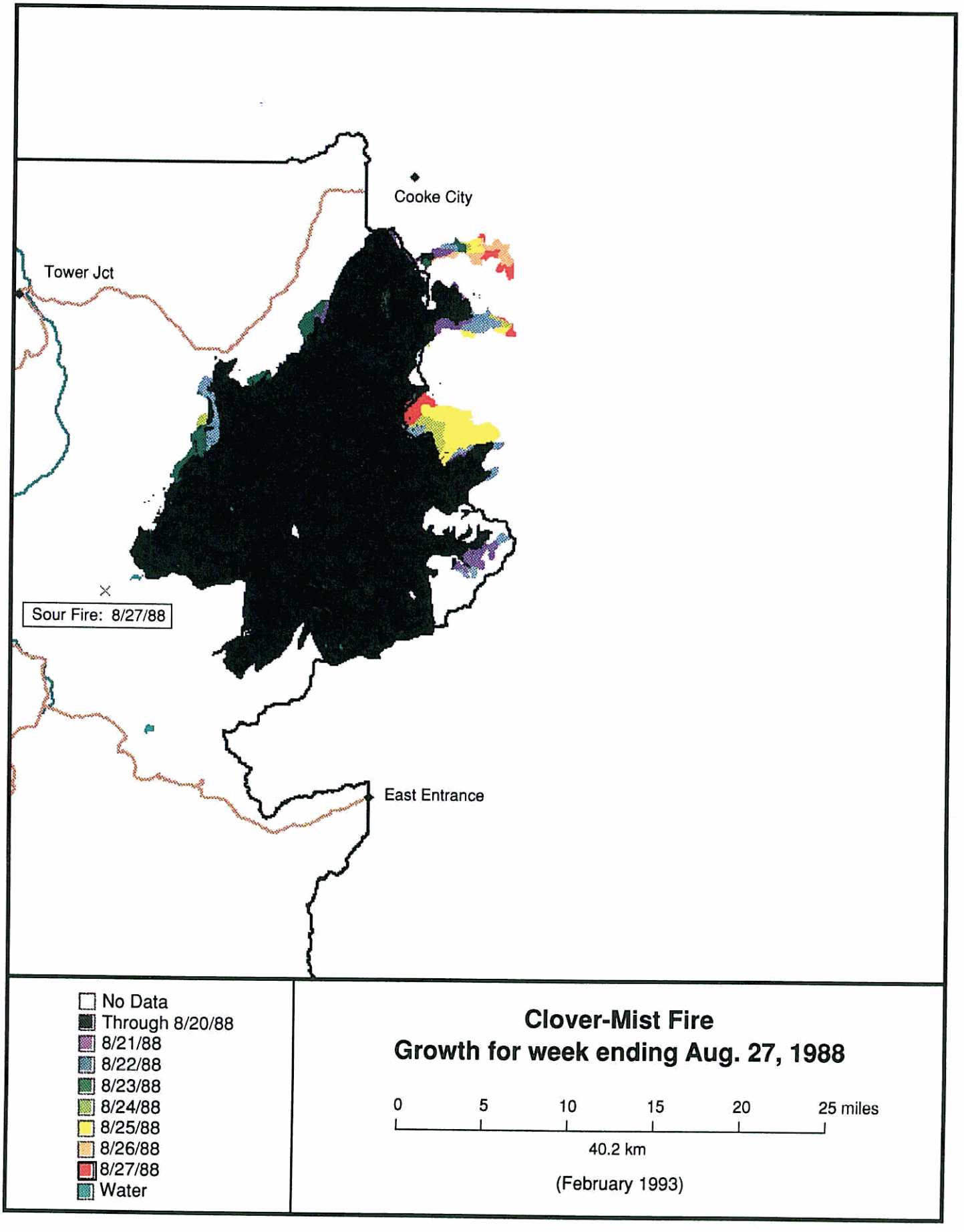

Cooke City
Tower Jct
Lovely Fire: 7/20/88
East Entrance
No Data
Through 7/16/88
7/17/88
7/18/88
7/19/88
7/20/88
7/21/88
7/22/88
7/23/88
Water
Clover-Mist Fire
Growth for week ending July 23, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

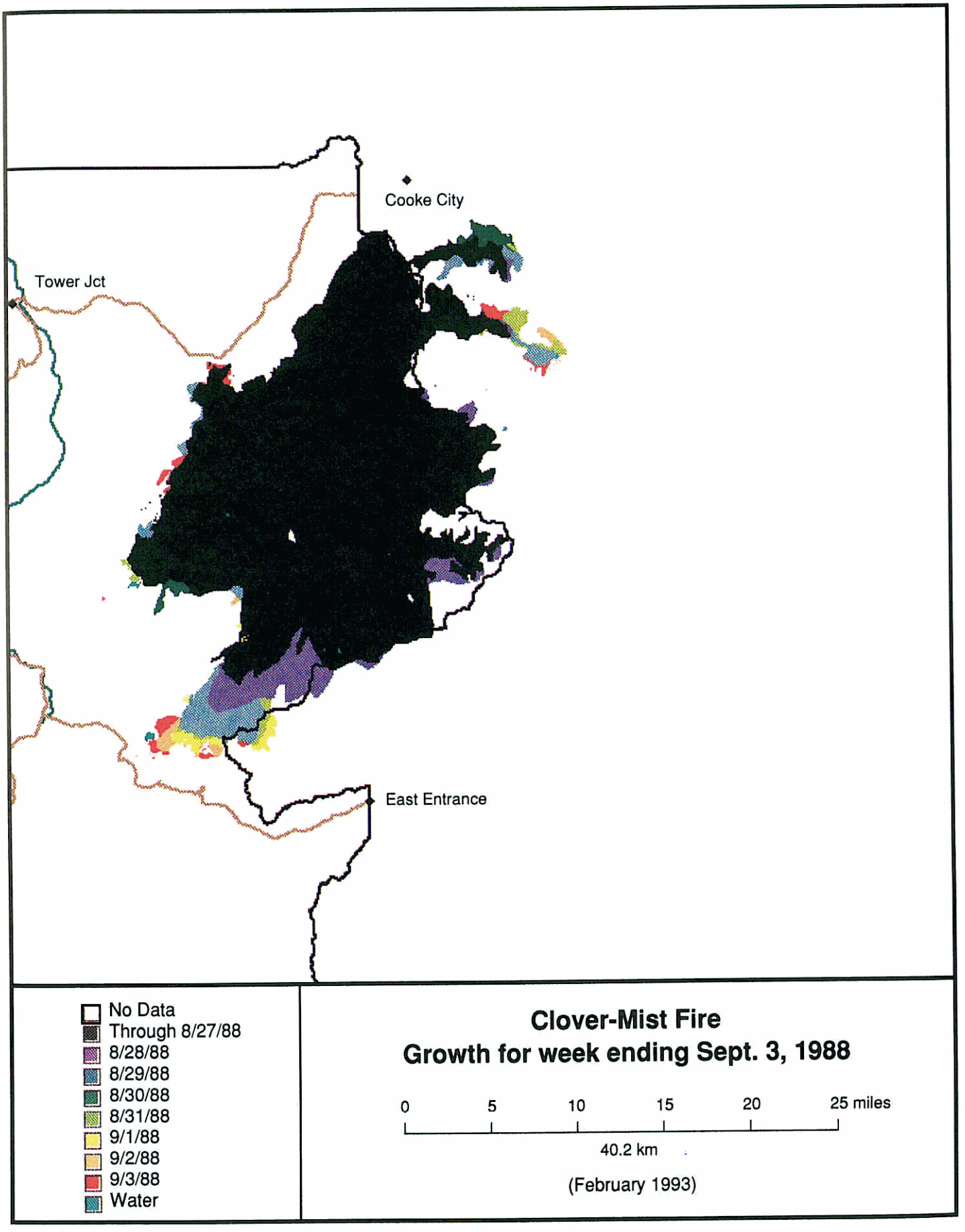

Cooke City
Tower Jct
East Entrance
No Data
Through 7/23/88
7/24/88
7/25/88
7/26/88
7/27/88
7/28/88
7/29/88
7/30/88
Water
Clover-Mist Fire
Growth for week ending July 30, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

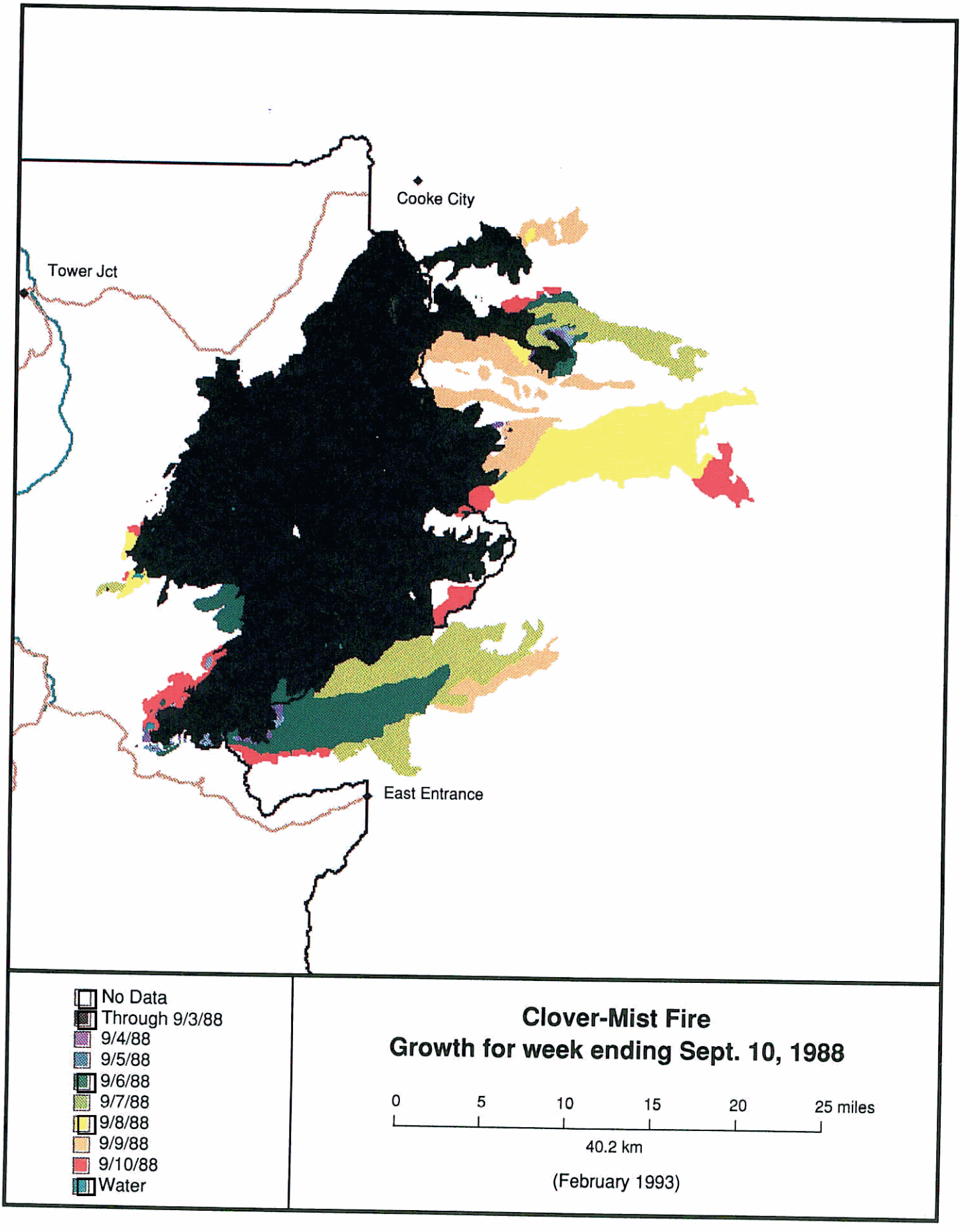

Cooke City
Tower Jct
Shallow Fire: 7/31/88
Fern Fire: 8/5/88
East Entrance
No Data
Through 7/30/88
7/31/88
8/1/88
8/2/88
8/3/88
8/4/88
8/5/88
8/6/88
Water
Clover-Mist Fire
Growth for week ending Aug. 6, 1988
0 5 10 15 20 25 miles
40.2 km
(February 1993)

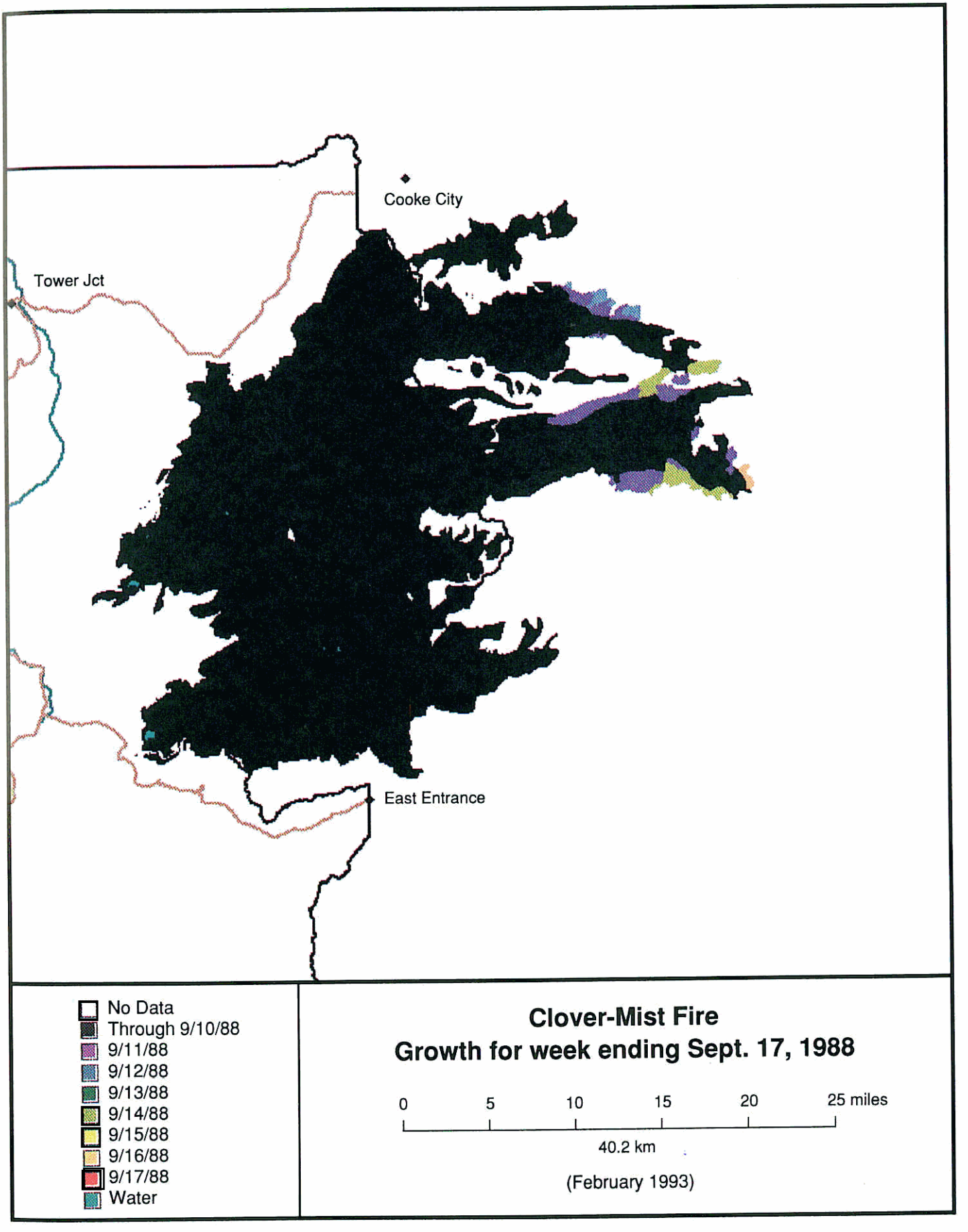

Cooke City
Tower Jct
East Entrance
No Data
Through 8/6/88
8/7/88
8/8/88
8/9/88
8/10/88
8/11/88
8/12/88
8/13/88
Water
Clover-Mist Fire
Growth for week ending Aug. 13, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

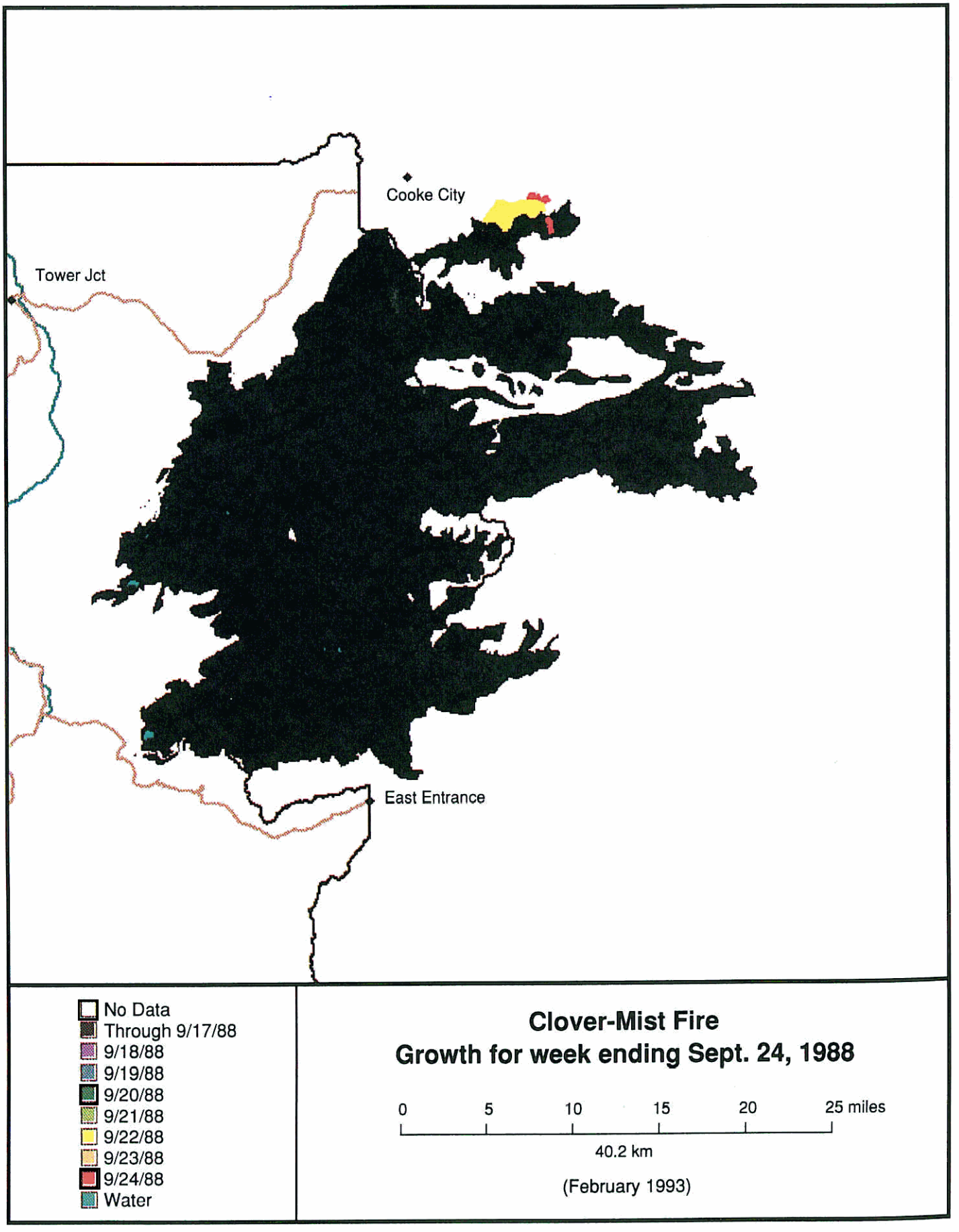

Cooke City
Tower Jct
East Entrance
No Data
Through 8/13/88
8/14/88
8/15/88
8/16/88
8/17/88
8/18/88
8/19/88
8/20/88
Water
Clover-Mist Fire
Growth for week ending Aug. 20, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

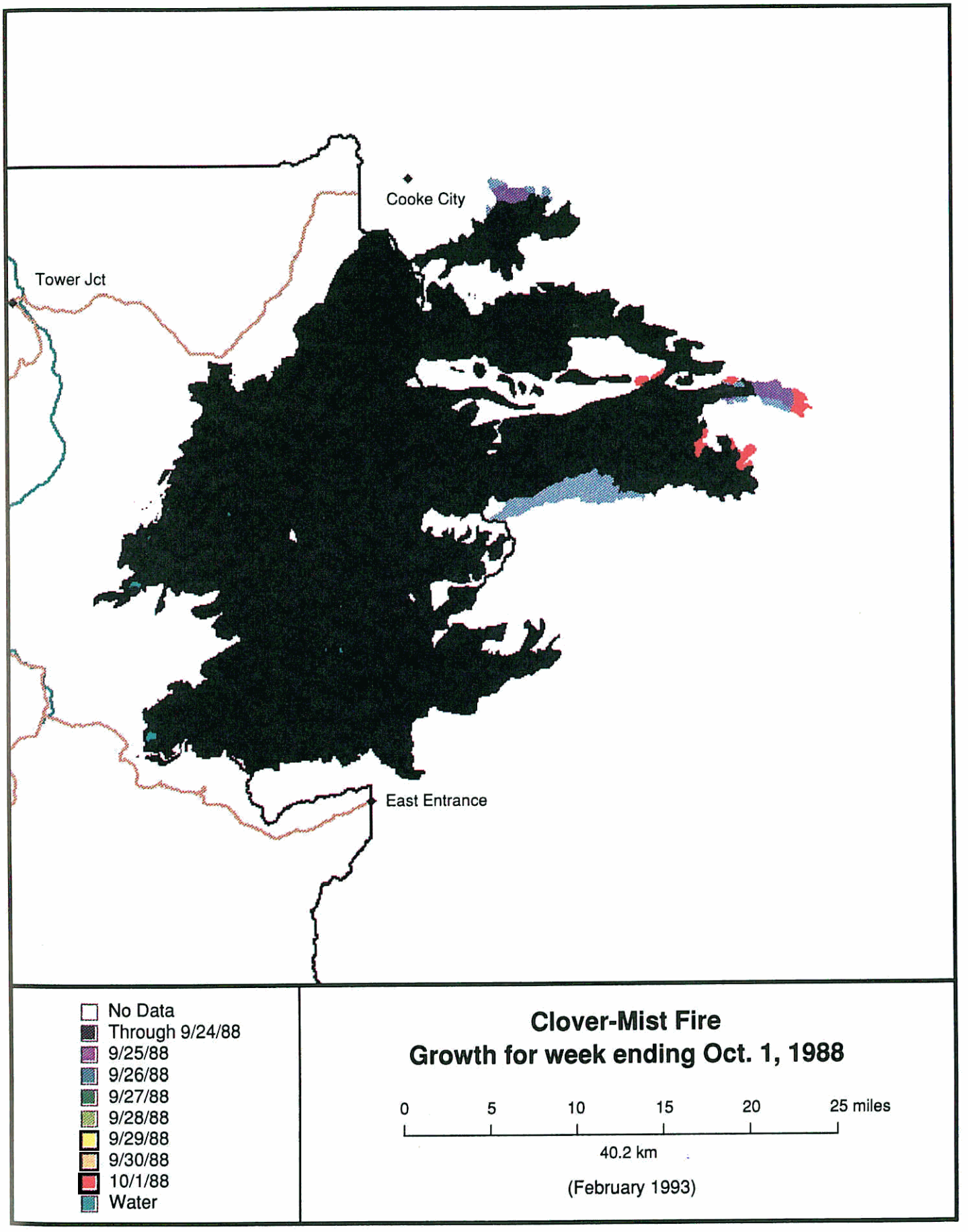

Cooke City
Tower Jct
Sour Fire: 8/27/88
East Entrance
No Data
Through 8/20/88
8/21/88
8/22/88
8/23/88
8/24/88
8/25/88
8/26/88
8/27/88
Water
Clover-Mist Fire
Growth for week ending Aug. 27, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

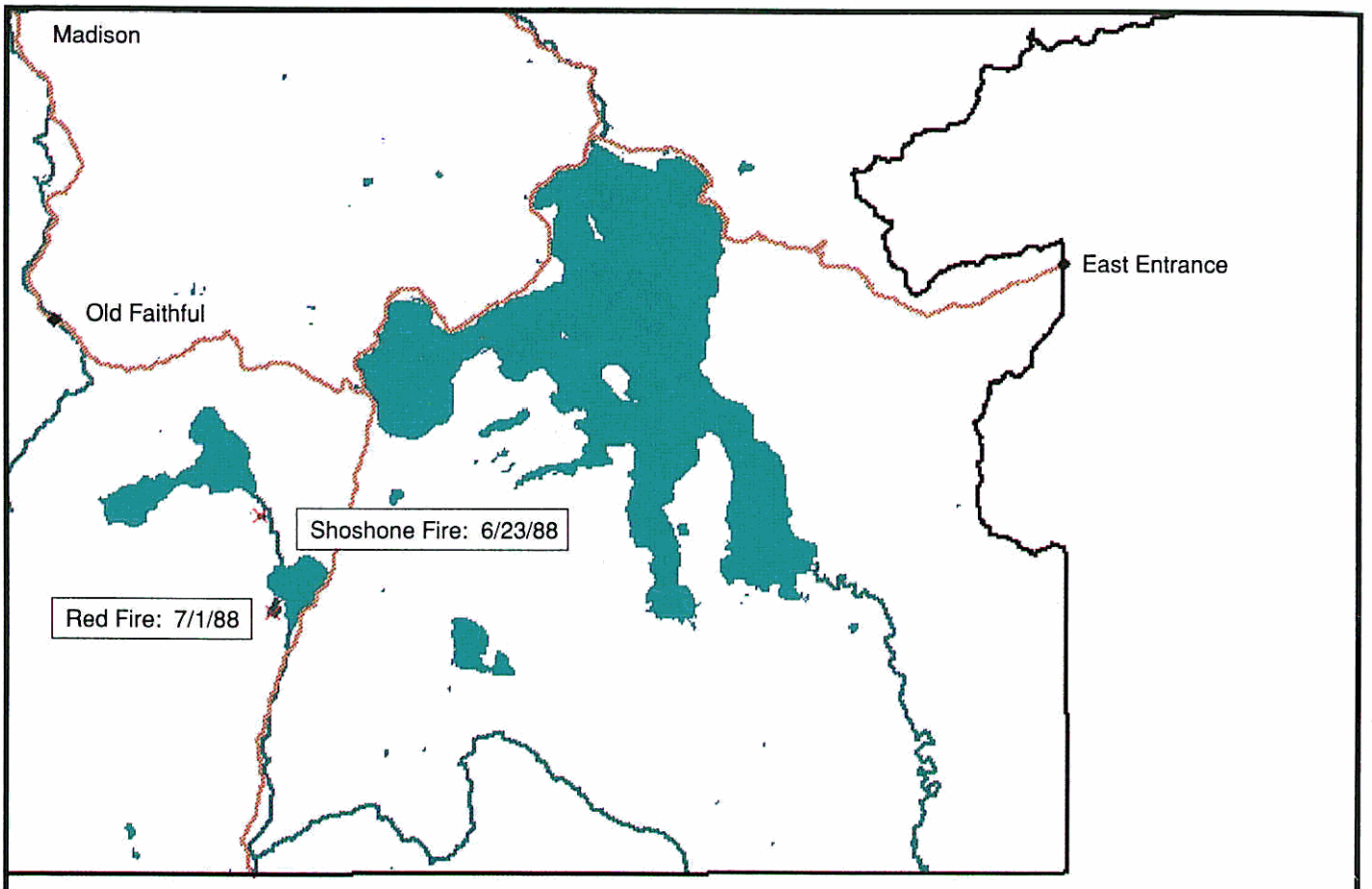

Cooke City
Tower Jct
East Entrance
No Data
Through 8/27/88
8/28/88
8/29/88
8/30/88
8/31/88
9/1/88
9/2/88
9/3/88
Water
Clover-Mist Fire
Growth for week ending Sept. 3, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)


Cooke City
Tower Jct
East Entrance
No Data
Through 9/3/88
9/4/88
9/5/88
9/6/88
9/7/88
9/8/88
9/9/88
9/10/88
Water
Clover-Mist Fire
Growth for week ending Sept. 10, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)


Cooke City
Tower Jct
East Entrance
No Data
Through 9/10/88
9/11/88
9/12/88
9/13/88
9/14/88
9/15/88
9/16/88
9/17/88
Water
Clover-Mist Fire
Growth for week ending Sept. 17, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)


Cooke City
Tower Jct
East Entrance
No Data
Through 9/17/88
9/18/88
9/19/88
9/20/88
9/21/88
9/22/88
9/23/88
9/24/88
Water
Clover-Mist Fire
Growth for week ending Sept. 24, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)


Cooke City
Tower Jct
East Entrance
No Data
Through 9/24/88
9/25/88
9/26/88
9/27/88
9/28/88
9/29/88
9/30/88
10/1/88
Water
Clover-Mist Fire
Growth for week ending Oct. 1, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)



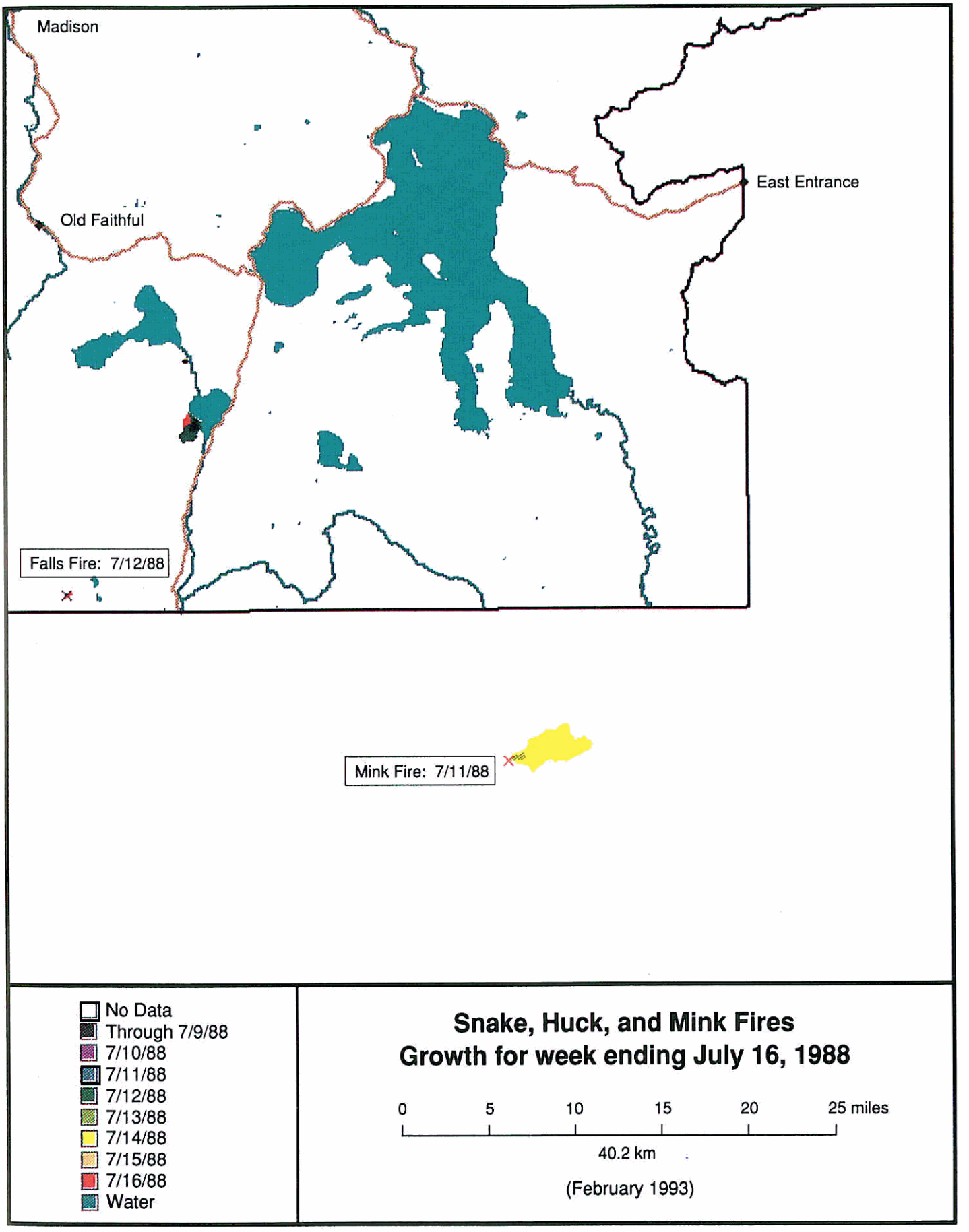
No Data
Through 7/2/88
7/3/88
7/4/88
7/5/88
7/6/88
7/7/88
7/8/88
7/9/88
Water

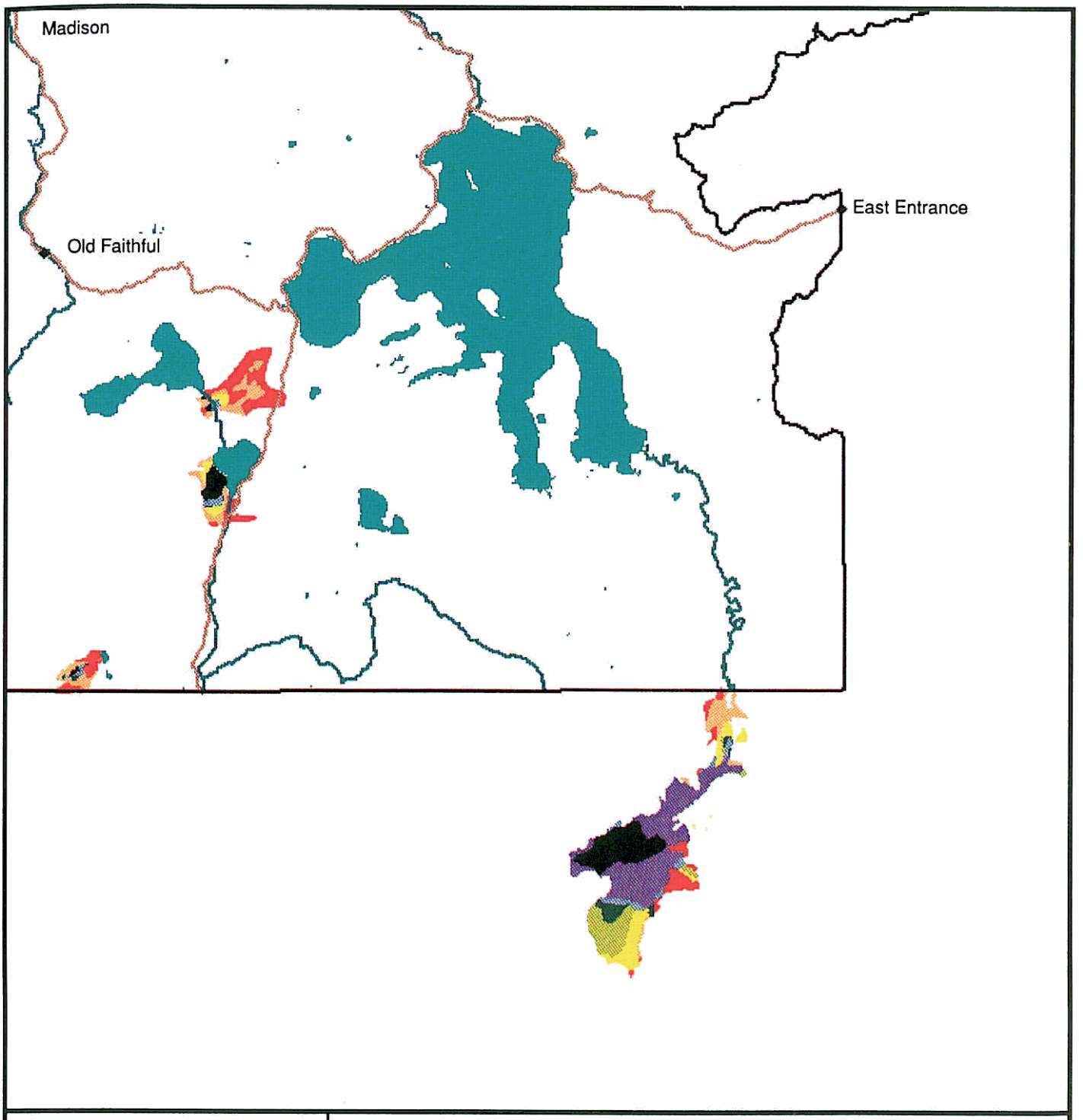
Snake, Huck, and Mink Fires
Growth for week ending July 9, 1988

0 5 10 15 20 25 miles

40.2 km

(February 1993)


Madison
Old Faithful
East Entrance
Falls Fire: 7/12/88
Mink Fire: 7/11/88
No Data
Through 7/9/88
7/10/88
7/11/88
7/12/88
7/13/88
7/14/88
7/15/88
7/16/88
Water
Snake, Huck, and Mink Fires
Growth for week ending July 16, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)



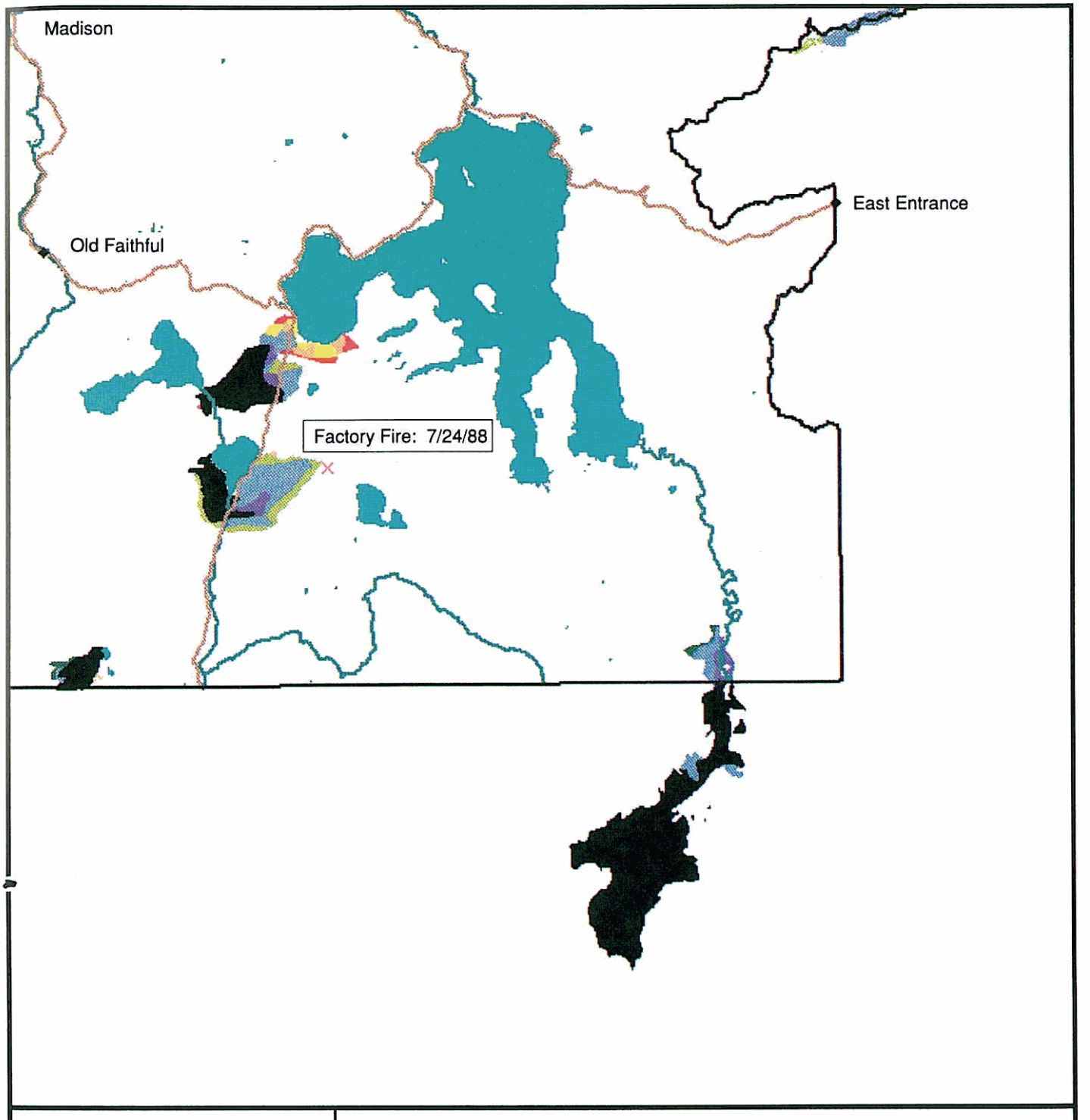
No Data
Through 7/16/88
7/17/88
7/18/88
7/19/88
7/20/88
7/21/88
7/22/88
7/23/88
Water

Snake, Huck, and Mink Fires
Growth for week ending July 23, 1988

0 5 10 15 20 25 miles

40.2 km

(February 1993)



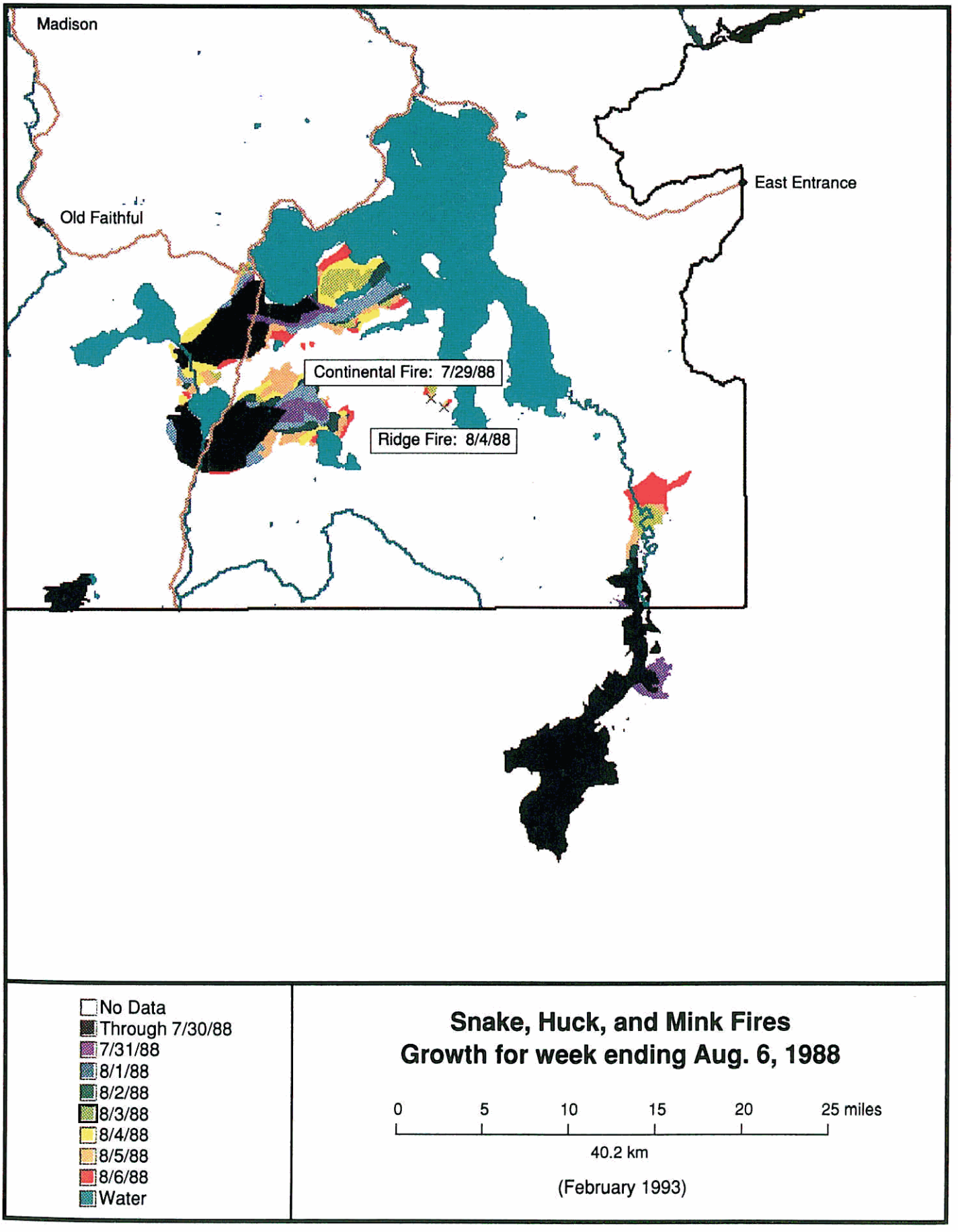
No Data
Through 7/23/88
7/24/88
7/25/88
7/26/88
7/27/88
7/28/88
7/29/88
7/30/88
Water

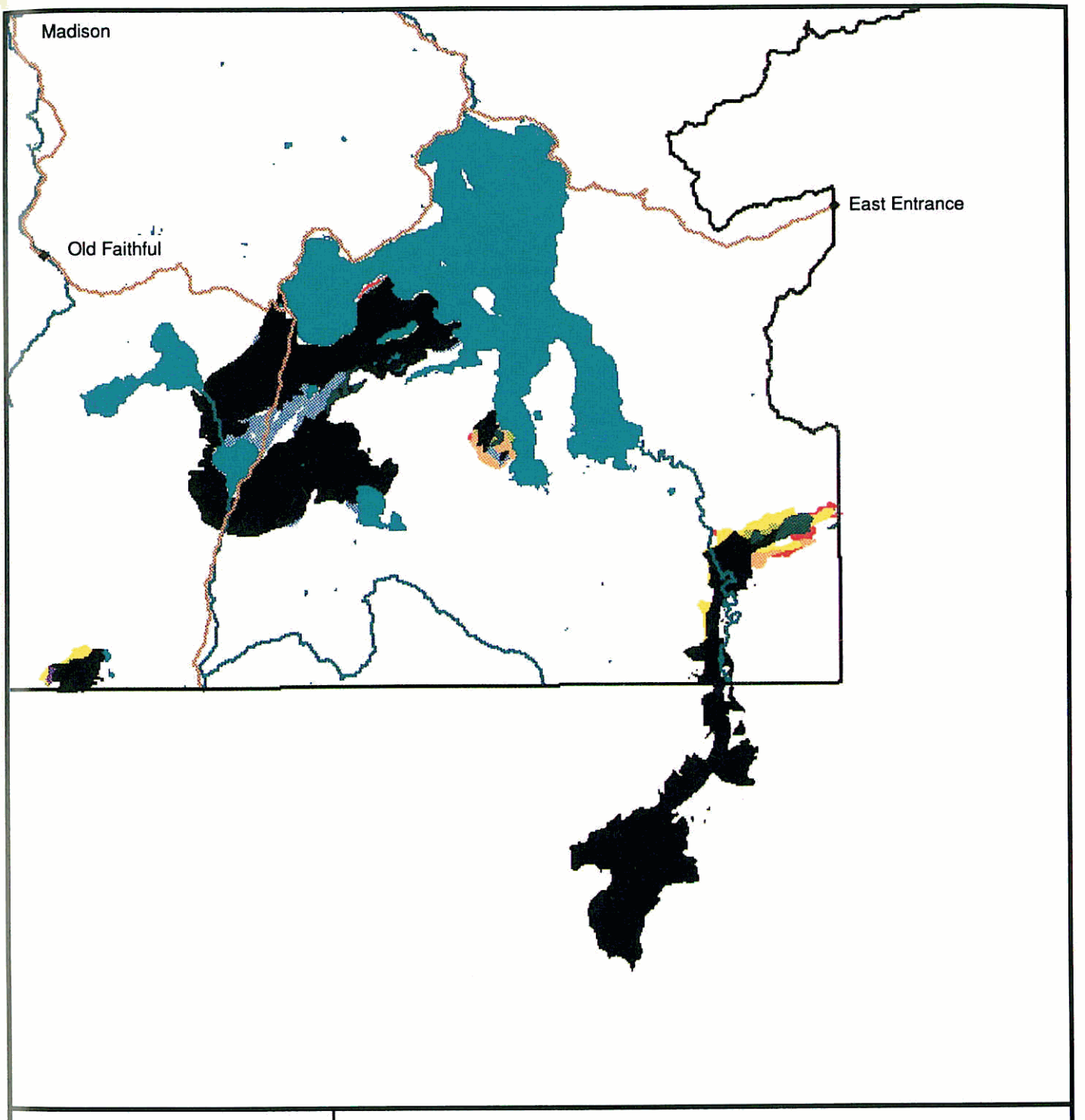
Snake, Huck, and Mink Fires
Growth for week ending July 30, 1988

0 5 10 15 20 25 miles

40.2 km

(February 1993)


Madison
Old Faithful
East Entrance
Continental Fire: 7/29/88
Ridge Fire: 8/4/88
No Data
Through 7/30/88
7/31/88
8/1/88
8/2/88
8/3/88
8/4/88
8/5/88
8/6/88
Water
Snake, Huck, and Mink Fires
Growth for week ending Aug. 6, 1988
0 5 10 15 20 25 miles
40.2 km
(February 1993)



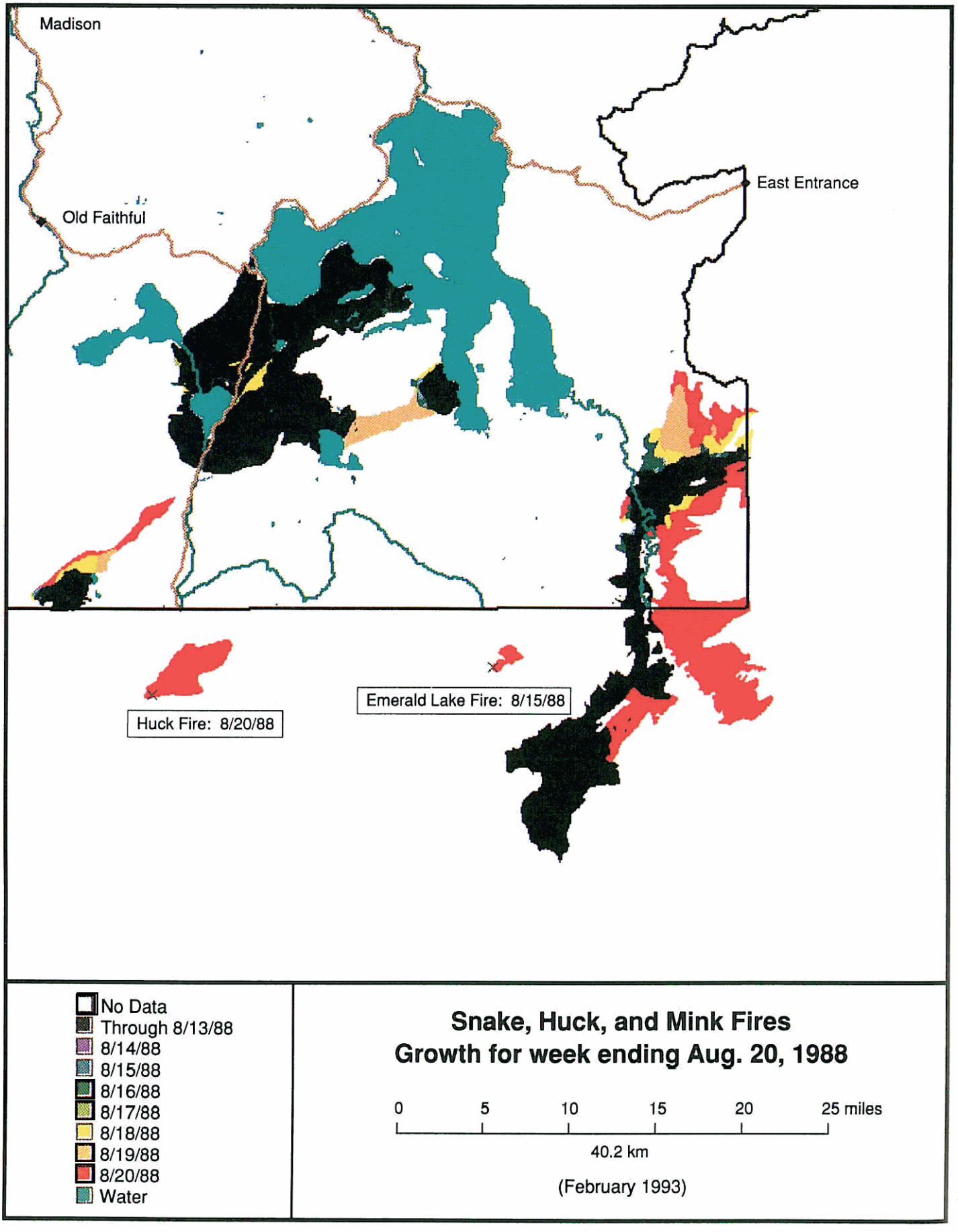
No Data
Through 8/6/88
8/7/88
8/8/88
8/9/88
8/10/88
8/11/88
8/12/88
8/13/88
Water

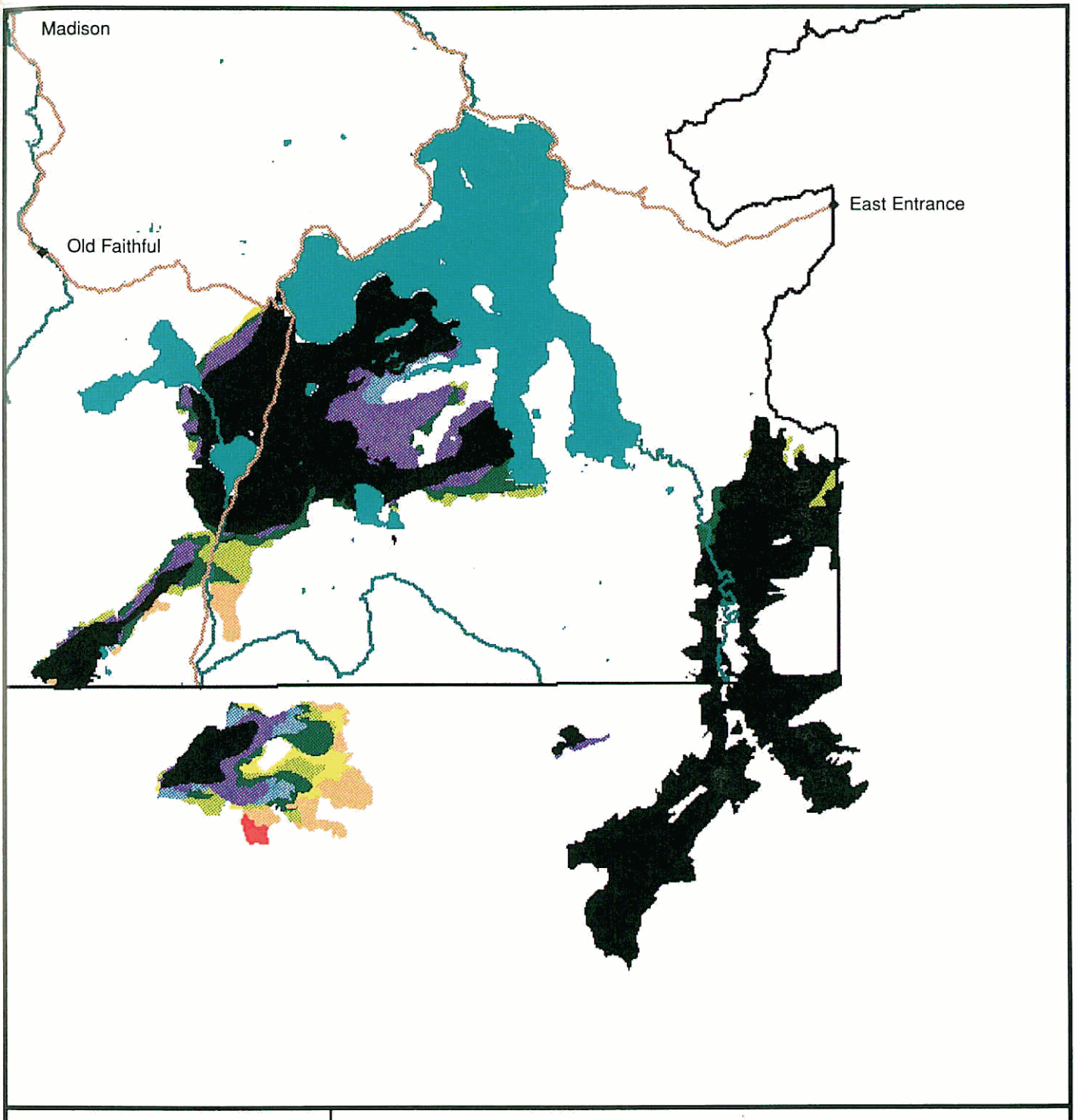
Snake, Huck, and Mink Fires
Growth for week ending Aug. 13, 1988

0 5 10 15 20 25 miles

40.2 km

(February 1993)


Madison
Old Faithful
East Entrance
Huck Fire: 8/20/88
Emerald Lake Fire: 8/15/88
No Data
Through 8/13/88
8/14/88
8/15/88
8/16/88
8/17/88
8/18/88
8/19/88
8/20/88
Water
Snake, Huck, and Mink Fires
Growth for week ending Aug. 20, 1988
0 5 10 15 20 25 miles
40.2 km
(February 1993)



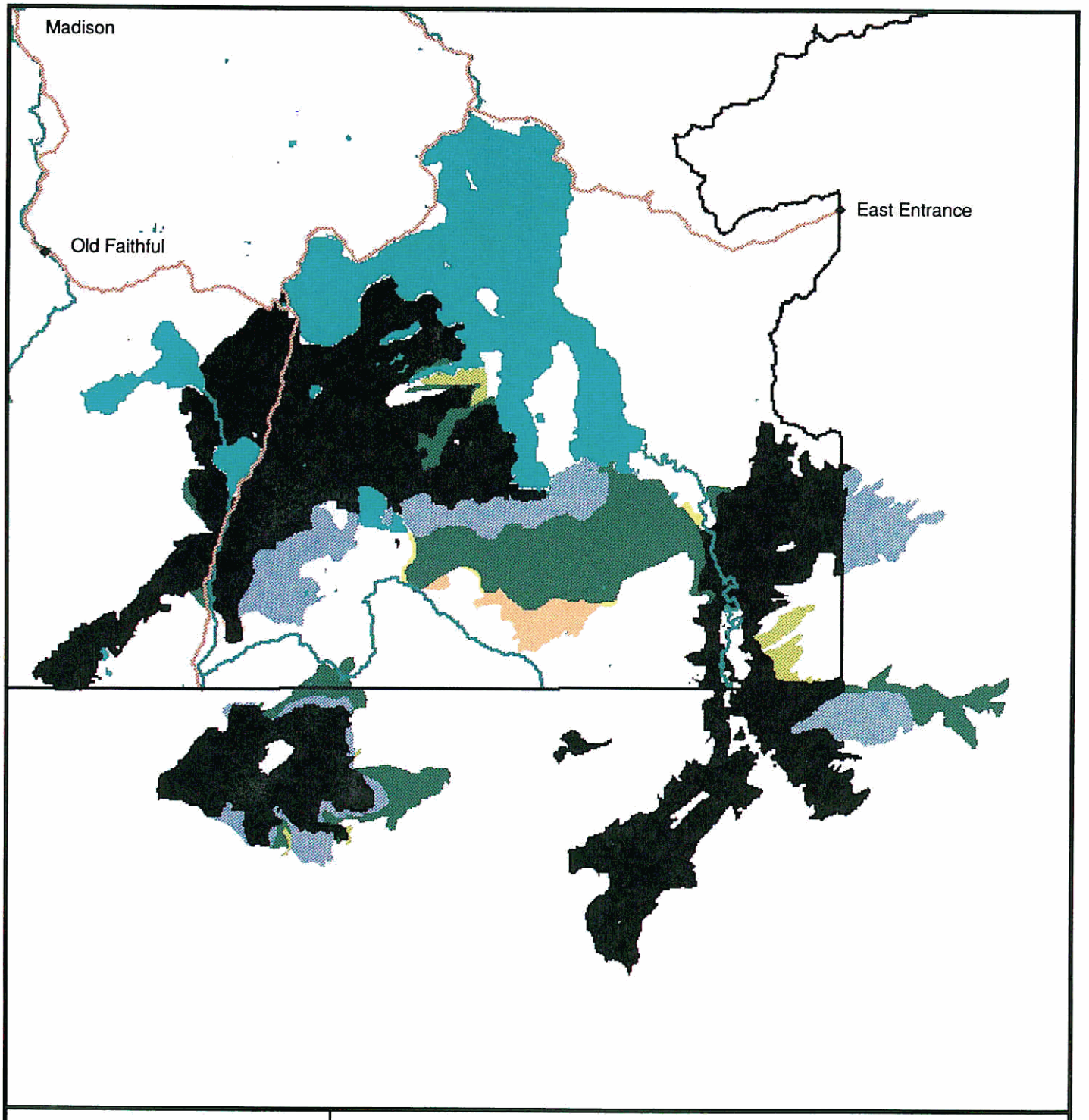
No Data
Through 8/20/88
8/21/88
8/22/88
8/23/88
8/24/88
8/25/88
8/26/88
8/27/88
Water

Snake, Huck, and Mink Fires
Growth for week ending Aug. 27, 1988

0 5 10 15 20 25 miles

40.2 km

(February 1993)



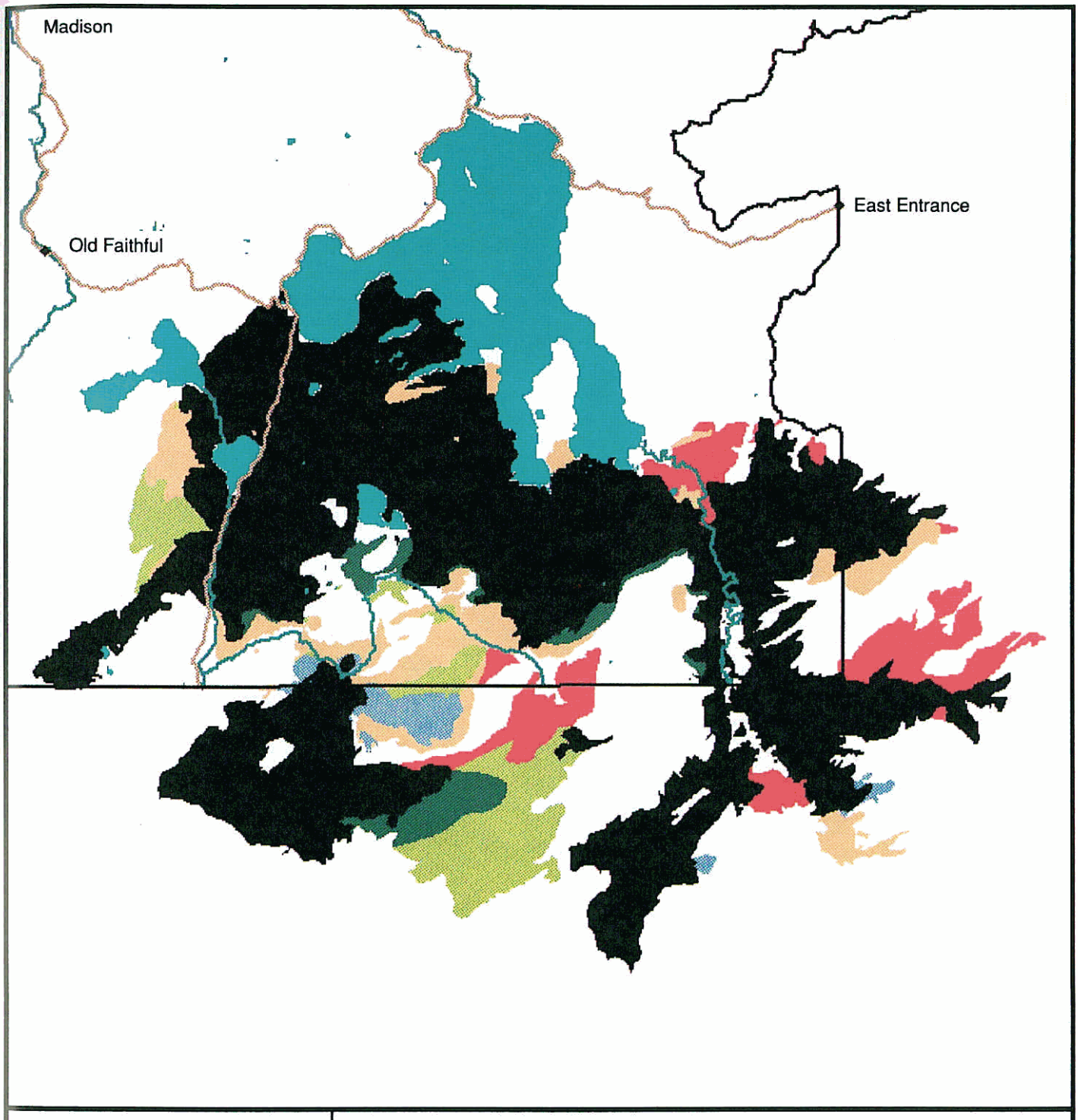
No Data
Through 8/27/88
8/28/88
8/29/88
8/30/88
8/31/88
9/1/88
9/2/88
9/3/88
Water

Snake, Huck, and Mink Fires
Growth for week ending Sept. 3, 1988

0 5 10 15 20 25 miles

40.2 km

(February 1993)



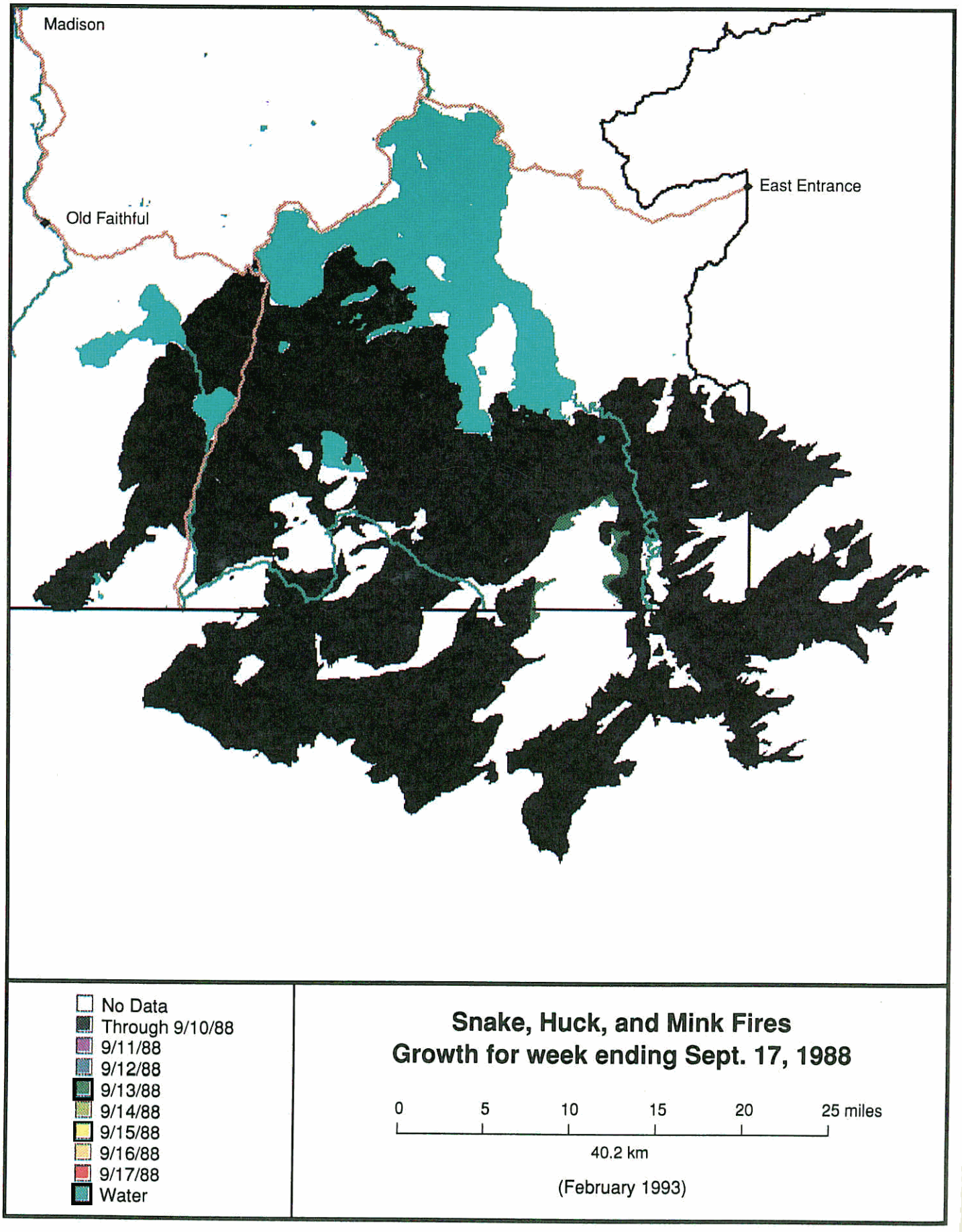
No Data
Through 9/3/88
9/4/88
9/5/88
9/6/88
9/7/88
9/8/88
9/9/88
9/10/88
Water

Snake, Huck, and Mink Fires
Growth for week ending Sept. 10, 1988

0 5 10 15 20 25 miles

40.2 km

(February 1993)


Madison
Old Faithful
East Entrance
No Data
Through 9/10/88
9/11/88
9/12/88
9/13/88
9/14/88
9/15/88
9/16/88
9/17/88
Water
Snake, Huck, and Mink Fires
Growth for week ending Sept. 17, 1988
0
5
10
15
20
25 miles
40.2 km
(February 1993)

APPENDIX B: THE ELECTRONIC DATA BASE

The electronic data set is a GRASS (U.S. Army Construction Engineering Research Laboratory 1988) mapset of approximately 3.5 megabytes, which has a Universal Transverse Mercator (UTM) zone 12 projection and is bounded by the following coordinates (meters):

North:	5034650
South:	4851650
East:	634200
West:	477850.

Elements of the mapset are described in the following table:

Type	Name	Description
Vector	perimeters	0.001-inch digitizing resolution from 1:62,500 and 1:24,000 U.S. Geological Survey quads; contains daily burn period positions
Raster	perimeter	50- x 50-m resolution; a composite derived from the digitized perimeters vector file with water-covered areas taken out; attributes (categories) are the first confirmed date for burning of the area
Raster	firemasks	50- x 50-m resolution; a masking layer which can be used to separate individual fires for analysis purposes; the fires are mutually exclusive and exhaustive with regard to areas burned
Sites	starts	Fire-start locations labeled by date of start

The electronic data set for fire growth is available from:

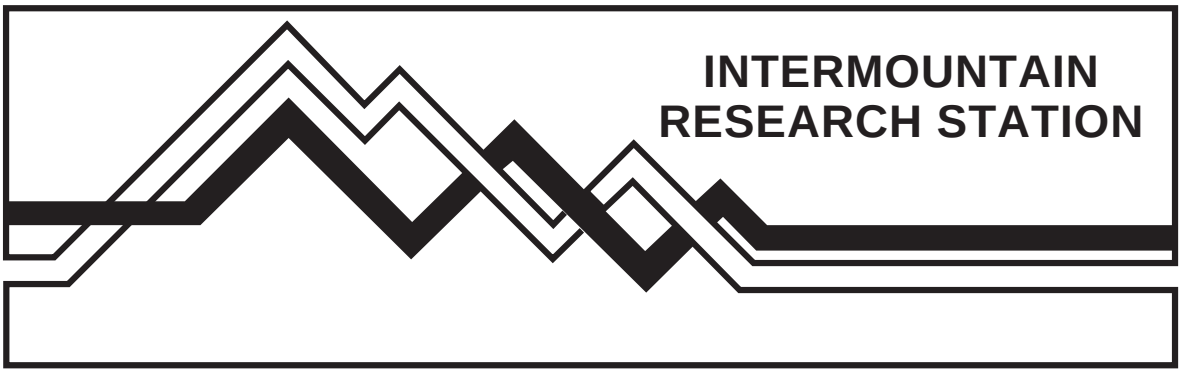
National Park Service
P.O. Box 168
Yellowstone National Park, WY 82190

Rothermel, Richard C.; Hartford, Roberta A.; Chase, Carolyn H. 1994. Fire growth maps for the 1988 Greater Yellowstone Area Fires. Gen. Tech. Rep. INT-304. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 64 p.

Daily fire growth maps display the growth of the 1988 fires in the Greater Yellowstone Area. Information and data sources included daily infrared photography flights, satellite imagery, ground and aerial reconnaissance, command center intelligence, and the personal recollections of fire behavior observers. Fire position was digitized from topographic maps using GRASS GIS software to construct a file of daily fire location in vector format, later converted to raster format for further analysis. The data base is available in electronic form.

KEYWORDS: forest fires, fire growth, geographic information systems, Yellowstone National Park, fire mapping

---



The Intermountain Research Station provides scientific knowledge and technology to improve management, protection, and use of the forests and rangelands of the Intermountain West. Research is designed to meet the needs of National Forest managers, Federal and State agencies, industry, academic institutions, public and private organizations, and individuals. Results of research are made available through publications, symposia, workshops, training sessions, and personal contacts.

The Intermountain Research Station territory includes Montana, Idaho, Utah, Nevada, and western Wyoming. Eighty-five percent of the lands in the Station area, about 231 million acres, are classified as forest or rangeland. They include grasslands, deserts, shrublands, alpine areas, and forests. They provide fiber for forest industries, minerals and fossil fuels for energy and industrial development, water for domestic and industrial consumption, forage for livestock and wildlife, and recreation opportunities for millions of visitors.

Several Station units conduct research in additional western States, or have missions that are national or international in scope.

Station laboratories are located in:

Boise, Idaho

Bozeman, Montana (in cooperation with Montana State University)

Logan, Utah (in cooperation with Utah State University)

Missoula, Montana (in cooperation with the University of Montana)

Moscow, Idaho (in cooperation with the University of Idaho)

Ogden, Utah

Provo, Utah (in cooperation with Brigham Young University)

Reno, Nevada (in cooperation with the University of Nevada)