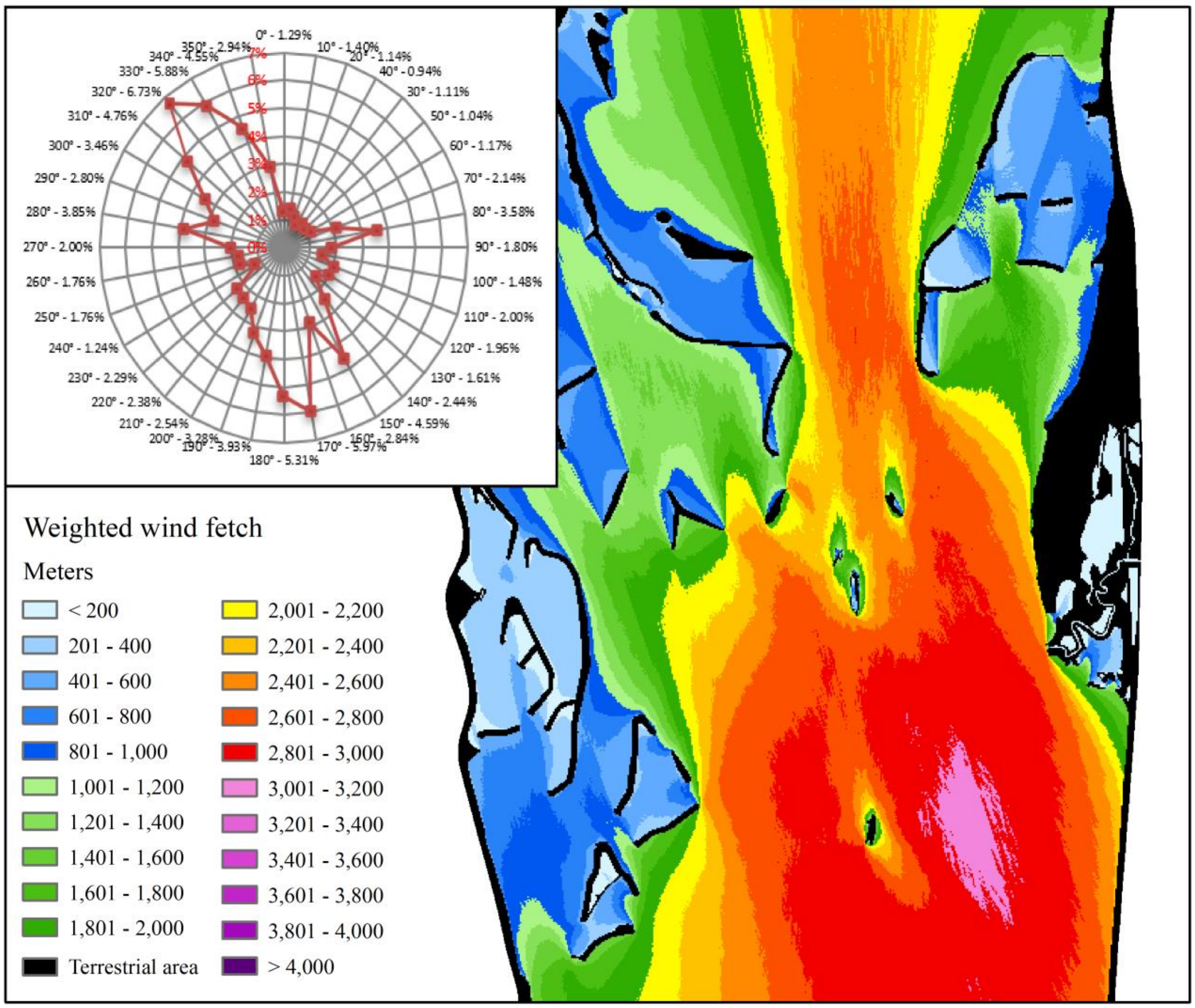
Upper Mississippi River System Weighted Wind Fetch Analysis (1989, 2000, 2010/2011)



U.S. Department of the Interior
U.S. Geological Survey

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Upper Mississippi River System Weighted Wind Fetch Analysis (1989, 2000, 2010/2011)

By

Jason Rohweder

and

James Rogala

U.S. Geological Survey
Upper Midwest Environmental Sciences Center
2630 Fanta Reed Road
La Crosse, Wisconsin 54603

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Cover image is a depiction of weighted wind fetch results for lower pool 8, Upper Mississippi River System using land cover data from 2010. Radar graph in upper left corner shows the graphical breakdown of wind direction frequencies from the La Crosse Municipal Airport Local Climatological Data station.

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Introduction

Wind fetch is defined as the unobstructed distance that wind can travel over water in a constant direction. Fetches are limited by landforms surrounding the body of water. Fetch is an important characteristic of open water because longer fetches can result in larger wind-generated waves. The larger waves, in turn, can increase shoreline erosion and sediment resuspension (Rohweder and others 2012). Increases in sediment resuspension lead to increases in water turbidity, which in turn decreases light penetration and, therefore, create conditions less conducive to aquatic plant growth (Giblin and others 2010).

A wind fetch model was developed by David Finlayson, U. S. Geological Survey, Pacific Science Center, while he was a Ph.D. student at the University of Washington (Finlayson 2005). This method calculates effective fetch using the recommended procedure of the Shore Protection Manual (USACE 1984). Scientists at the U.S. Geological Survey, Upper Midwest Environmental Sciences Center (UMESC) and the U.S. Army Corps of Engineers (USACE) further refined this model (Rohweder and others 2012) and structured it to operate using the most recent version of the ArcMap Geographic Information System platform (Esri, 2019). At the time the analysis was performed, the version of ArcMap used was 10.7.1. The model that was refined in 2012 was used for the analyses described in this report.

Using this model, UMESC performed an analysis to model weighted wind fetch for the Upper Mississippi River System (UMRS) corresponding to three separate time periods of land cover spatial data acquisition (1989, 2000, and 2010/2011). The purpose of the analysis was to examine how fetch varies over time and space within the UMRS for potential management applications. For more detailed information on the wind fetch model, examine the USGS Open-File Report by Rohweder and others (2012).

Methodology

Analysis Study Area

The study area for the weighted wind fetch analysis covered the mapped floodplain area of the UMRS from navigation pool 2 of the Upper Mississippi River near St. Paul, Minnesota, and extending south of Saint Louis, Missouri, near the confluence with the Ohio River. The Illinois River floodplain was also included extending from Lake Michigan to the confluence with the Mississippi River just north of Saint Louis (Figure 1). In this figure, and in additional figures throughout the report each pool is labeled according to a three-letter acronym. Those on the Mississippi River preceded by a “p” are short for “pool” (e.g., p12 refers to Pool 12). Additionally, on the Mississippi River “por” is short for “Open River Pool”, this is the un-impounded portion of the Mississippi River. On the Illinois River, “loc”, “bra”, “dre”, “mar”, “sta”, “peo”, “lag”, and “alt” refer to the Lockport, Brandon, Dresden, Marseilles, Starved Rock, Peoria, La Grange, and Alton Pools, respectively. Also, each pool is categorized into one of four geomorphic reaches, the upper impounded, lower impounded, and open river reaches on the Mississippi River, and the Illinois River reach. These are also displayed within Figure 1.

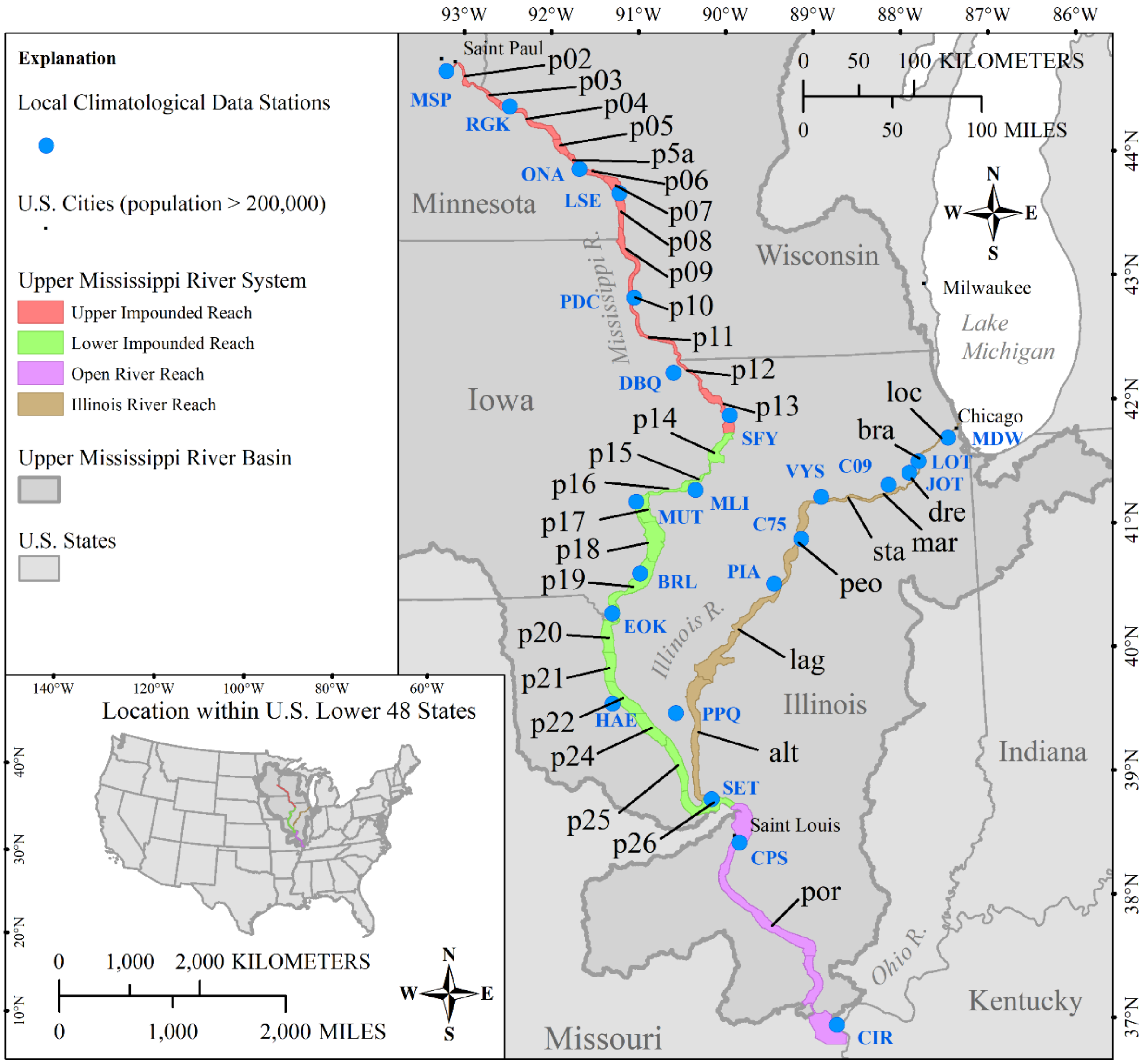

Figure 1. Overview map showing extent of area modeled for weighted wind fetch.

Land/Water Input Data

Land cover data created by the Upper Mississippi River Restoration (UMRR) Program's Long Term Resource Monitoring element (LTRM) were used to depict the land/water interface used within the wind fetch model (see Appendix 1 for detailed background information). For this analysis, only areas within the floodplain of the UMRS that were consistently mapped for each of the three separate years of system-wide land cover data production were included (1989, 2000, and 2010/2011). This was done to be able to calculate weighted wind fetch statistics for each time period using a consistent spatial footprint. Geospatial data layers were downloaded from http://www.umesc.usgs.gov/ltrm-home.html (date accessed 1/17/2020) for 1989, 2000, and 2010 /2011.

The LTRM land cover datasets were developed through interpretation of aerial imagery. Aerial photography was collected from August to September during the typical “low-water” time period on the UMRS. Low-water conditions occurred for all the navigation reaches mapped in 1989 and 2000 and for the navigation reaches north of p14 on the UMR and for the Alton (alt) to Marseilles (mar) reaches of the Illinois River in 2010. However, high water conditions occurred for the remainder of the river system during 2010, and thus, photography was collected for the remaining reaches during 2011. In 2011, water levels were still higher than those observed during either 1989 or 2000, but photography was collected on the remaining reaches regardless. Water levels ranged from 0.3 to 0.87 m higher for these reaches in August and September of 2011 than they were during the same months in 1989 and 2000 (De Jager and Rohweder 2017). These higher water levels make it difficult to make accurate comparisons between the amount of open water between each of the separate time periods (Figure 2). It is important to keep this in mind when analyzing changes in weighted wind fetch over time as some of the change is due to actual processes such as erosion, accretion, and construction, however, some of the change is due to the inconsistent water levels that existed at the time of photo acquisition. Each input land/water data set should not be considered representative of the entire year of acquisition, but a snapshot in time during that year. Additionally, small changes in shoreline extent could be due to differences in photointerpretation methods and positional accuracy that was achievable using the technology available at the time.

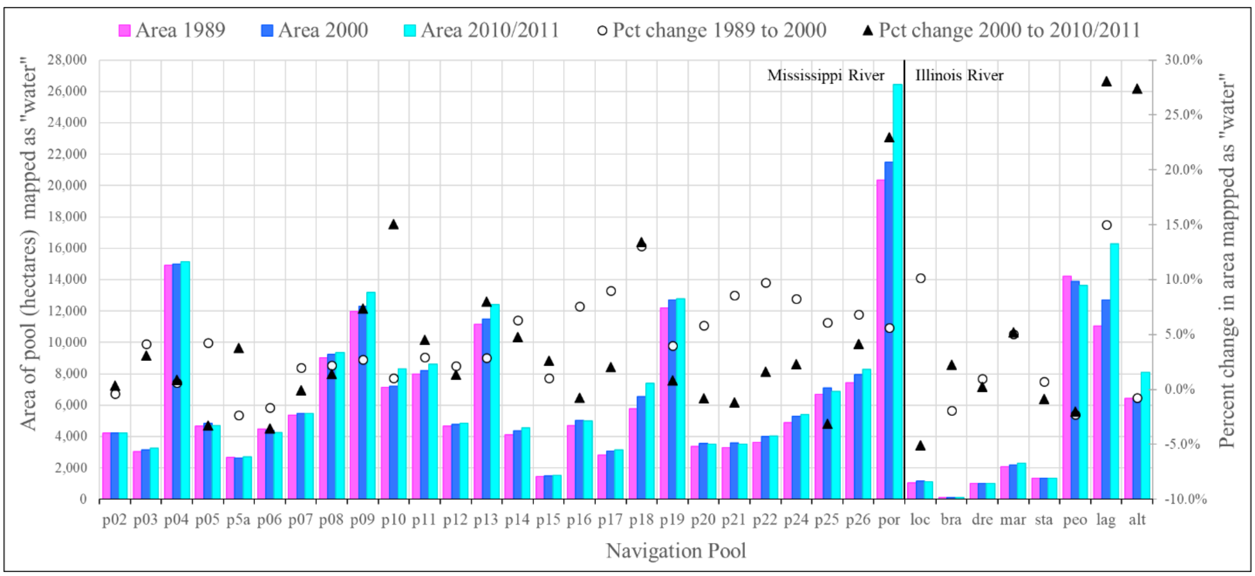

Figure 2. Change in total aquatic area within the mapped portions of each pool between 1989, 2000, and 2010/2011.

Wind Direction Input Data

Wind direction data used within the wind fetch model were collected from the Local Climatological Data, National Oceanic and Atmospheric Administration, National Centers for Environmental Information (NCEI; https://www.ncdc.noaa.gov/cdo-web/datatools/lcd, date accessed November 6, 2019). Data were collected from twenty-three separate stations along the UMRS (Figure 1, Table 1). These stations were selected due to their proximity to the UMRS and for having the relevant wind parameter collected and for the right time frame. Other sources of wind data were also investigated including those from the USACE, but they were not adequate for the intended analyses due to data collection discrepancies between stations and measured parameters not being relevant for this analysis.

Table 1. List of Local Climatological Data stations used in the analyses

LOC_ID	Name	Network:ID	Latitude/Longitude
MSP	Minneapolis St. Paul International Airport, MN, US	WBAN:14922	44.8831°, -93.2289°
RGK	Red Wing Regional Airport, WI, US	WBAN:04967	44.58917°, -92.48472°
ONA	Winona Municipal Max Conrad Field Airport, MN, US	WBAN:04956	44.07694°, -91.70806°
LSE	La Crosse Municipal Airport, WI, US	WBAN:14920	43.8788°, -91.2527°
PDC	Prairie Du Chien Municipal Airport, WI, US	WBAN:04963	43.01917°, -91.12361°
DBQ	Dubuque Regional Airport, IA, US	WBAN:94908	42.39778°, -90.70361°
SFY	Savanna Tri Township Airport, IL, US	WBAN:04996	42.04583°, -90.10806°
MLI	Moline Quad City International Airport, IL, US	WBAN:14923	41.46528°, -90.52333°
MUT	Muscatine Municipal Airport, IA, US	WBAN:04950	41.36667°, -91.15°
BRL	Burlington Municipal Airport, IA, US	WBAN:14931	40.78333°, -91.12528°
EOK	Keokuk Municipal Airport, IA, US	WBAN:04921	40.45972°, -91.42833°
HAE	Hannibal Regional Airport, MO, US	WBAN:00455	39.72516°, -91.44386°
SET	St Charles Co Airport, MO, US	WBAN:53904	38.92861°, -90.42806°
CPS	Cahokia St Louis Downtown Airport, IL, US	WBAN:03960	38.57139°, -90.15722°
CIR	Cairo Regional Airport, IL, US	WBAN:93809	37.06444°, -89.21944°
MDW	Chicago Midway Airport, IL, US	WBAN:14819	41.78611°, -87.75222°
LOT	Romeoville Weather Forecast Office, IL, US	WBAN:04831	41.60413°, -88.08497°
JOT	Joliet, IL, US	WBAN:14834	41.5°, -88.16667°
C09	Morris Municipal Jr Washburn Field Airport, IL, US	WBAN:04867	41.42528°, -88.41861°
VYS	Peru IL Valley Regional Walter A. Duncan Field Airport, IL, US	WBAN:04899	41.35167°, -89.15306°
C75	Lacon Marshall Co Airport, IL, US	WBAN:04868	41.01917°, -89.38639°
PIA	Peoria International Airport, IL, US	WBAN:14842	40.6675°, -89.6839°
PPQ	Pittsfield Penstone Municipal Airport, IL, US	WBAN:53950	39.63861°, -90.77833°

For this study we selected the hourly instantaneous wind direction parameter, which is defined as "the wind direction from true north using compass directions (e.g. 360 = true north, 180 = south, 270 = west, etc.)". A direction of "000" is given for calm winds and not used in this study. Wind data used in this analysis were collected only during the growing seasons (April 1st – July 31st) from 2010 to 2019. We used a definition of growing season that corresponded to the period of growth for aquatic vegetation and to correspond with conditions leading up to the time when LTRM samples aquatic vegetation. By doing so, future analyses that link wind fetch to patterns of aquatic plant communities are expected to be strengthened. Longer definitions of growing season that last through September are usually used for characterizing floodplain vegetation. The time period of 2010 to 2019 was used as data were not available before 2010 for all wind collection stations. Additionally, by using data from the same time period we can make more direct comparisons between the three time periods (1989, 2000, and 2010/2011). It is possible that wind direction patterns have changed somewhat from 1989 to 2019 but this was not investigated as part of this study. All wind direction measurements with speeds greater than zero miles per hour were used. Figure 3 gives an example of NCEI local climatological data for May 2019 from the La Crosse Municipal Airport. The attribute used is labeled “Wind Dir (Deg)”.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Current Location: Elev: 652 ft. Lat: 43.8788° N Lon: -91.2527° W
Station: **LA CROSSE MUNICIPAL AIRPORT, WI US WBAN: 72643014920 (KLSE)**

Local Climatological Data
Hourly Observations
July 2019
Generated on 07/22/2020

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

<table>
<tr><th rowspan="2">Date</th><th rowspan="2">Time (LST)</th><th rowspan="2">Station Type</th><th rowspan="2">Sky Conditions</th><th rowspan="2">Visibility</th><th>Weather Type (see documentation)</th><th colspan="2">Dry Bulb Temp</th><th colspan="2">Wet Bulb Temp</th><th colspan="2">Dew Point Temp</th><th rowspan="2">Rel Hum %</th><th rowspan="2">Wind Speed (MPH)</th><th rowspan="2">Wind Dir (Deg)</th><th rowspan="2">Wind Gusts (MPH)</th><th rowspan="2">Station Press (inHg)</th><th rowspan="2">Press. Tend</th><th rowspan="2">Net 3-Hr Change (inHg)</th><th rowspan="2">Sea Level Press. (inHg)</th><th rowspan="2">Report Type</th><th rowspan="2">Precip Total (in)</th><th rowspan="2">Altimeter Setting (inHg)</th></tr>
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<tr><td>01</td><td>1353</td><td>7</td><td>SCT:04 80</td><td>10.00</td><td></td><td>85</td><td>29.4</td><td>74</td><td>23.3</td><td>69</td><td>20.6</td><td>59</td><td>11</td><td>190</td><td></td><td>29.24</td><td></td><td></td><td>29.90</td><td>FM-15</td><td>0.00</td><td>29.94</td></tr>
<tr><td>01</td><td>1453</td><td>7</td><td>FEW:02 43
OVC:08 65</td><td>10.00</td><td></td><td>85</td><td>29.4</td><td>73</td><td>22.8</td><td>67</td><td>19.4</td><td>55</td><td>7</td><td>220</td><td></td><td>29.23</td><td>8</td><td>+0.04</td><td>29.89</td><td>FM-15</td><td>0.00</td><td>29.93</td></tr>
<tr><td>01</td><td>1553</td><td>7</td><td>OVC:08 37</td><td>10.00</td><td></td><td>84</td><td>28.9</td><td>73</td><td>22.8</td><td>68</td><td>20.0</td><td>59</td><td>5</td><td>VRB</td><td></td><td>29.21</td><td></td><td></td><td>29.88</td><td>FM-15</td><td>0.00</td><td>29.91</td></tr>
<tr><td>01</td><td>1643</td><td>7</td><td>OVC:08 33</td><td>1.50</td><td>+RA:02 |RA |RA</td><td>77</td><td>25.0</td><td>73</td><td>22.8</td><td>71</td><td>21.7</td><td>82</td><td>5</td><td>010</td><td></td><td>29.20</td><td></td><td></td><td></td><td>FM-16</td><td>0.04</td><td>29.90</td></tr>
</table>

Figure 3. Sample National Oceanic and Atmospheric Administration, National Centers for Environmental Information, Local Climatological Data summary sheet

Weighted Wind Fetch Analysis

Wind fetch was calculated using the wind fetch model at 10-degree increments around the entire compass for each navigation pool outlined in the section “Analysis Study Area” above. When the model is initiated, the “Calculation Method” defaults to Shore Protection Manual (SPM) methodology. The SPM process uses the preferred methodology for calculating effective fetch as described in the Shore Protection Manual (USACE 1984). This method spreads nine radials around the desired wind direction at 3-degree increments. The resultant wind fetch is the arithmetic average of these nine radial measurements. For the wind fetch analysis used within this report, the SPM method was used. The larger arc (24 degrees) probably represents a more real-world condition for the areas evaluated. Wave refraction was not considered; however, in the examples provided, the large arc takes this into account and more accurately predicts what the shadow zone might be around an island. Next, the frequency of wind direction measurements were calculated for each 10-degree direction and for each weather station for the entire 10-year time span.

The percent frequency of each of these wind directions was then interpolated for each UMRS navigation pool that falls in-between each weather station. The river mile assigned to each pool was determined by using the centroid of each pool boundary and assigning the river mile closest to this centroid. The closer the pool is to a weather station, the more influence that weather station's wind frequency values will have on that pool. If a pool falls in between two weather stations this method gives weight to each station based upon the relative distance to each. In the absence of a designated wind collection station for each pool, this was decided to be the most appropriate method for estimating the percent frequency of winds. As you get farther away from a weather station, the likelihood that the wind frequency patterns for that weather station will continue to accurately represent what is happening on a particular pool becomes increasingly less likely but this method attempts to take into account this variability. The topography of the surrounding landscape and the relative elevation of the weather station compared to the pool itself can potentially influence wind direction patterns. The magnitude of this effect was not investigated in this report.

This interpolation was accomplished by first identifying the nearest wind station and associated river mile upstream and downstream from that pool. The individual weighting for each 10-degree direction was calculated according to the following formula for each pool:

$$pctP = pctD + (pctU - pctD) * ((rmP - rmD)/(rmU - rmD))$$

Where:

$pctP$ = percent frequency of wind from that direction calculated for the navigation pool
$pctD$ = percent frequency of wind from that direction reported at downstream wind station
$pctU$ = percent frequency of wind from that direction reported at upstream wind station
rmP = closest river mile to navigation pool being analyzed
rmD = closest river mile to downstream wind station
rmU = closest river mile to upstream wind station

This method gives weighting to the wind frequency patterns from weather stations both upstream and downstream from each pool, but gives more weighting to stations that are closest, and thereby presumably more relevant, to that pool. For the Mississippi River pools analyzed for this study, the average distance of each pool centroid (excluding the open river portion) to the nearest weather station was 14 river miles, the minimum distance was 0 river miles and the maximum was 41 river miles. For the Illinois River pools analyzed, the average distance was 13 river miles, the minimum distance was 1 river mile, and the maximum was 49 river miles.

Appendix 2 gives the percent breakdown of wind direction frequencies used to calculate weighted wind fetch for each pool on the Upper Mississippi and Illinois River developed using the formula above. These frequencies were then converted into a text file for each pool to be used within the wind fetch tool.

Individual wind fetch outputs were then calculated at each 10-degree increment for each navigation pool using the wind fetch model within the ArcMap geographic information system platform. Once each individual 10-degree incremental wind fetch raster was developed using the wind fetch model, the resultant pool output was then multiplied by the percent frequency (weight) of wind collected from that direction. Finally, each of these outputs for the 36 individual 10-degree increment rasters were summed by the tool to create the final weighted wind fetch output. This pool-wide analysis was repeated for each of the three input land/water data acquisition years; 1989, 2000, and 2010/2011.

Figure 4 is a graphical depiction of the methodology used to calculate weighted wind fetch for a specific reference raster cell within pool 8 of the UMRS taken from Rohweder et al. (2012). Wind fetch is calculated for each 10-degree increment, each resultant value (n = 36) is then multiplied by the frequency that wind was collected in that direction (weight). These values are then summed to get the weighted wind fetch value for that location on the landscape (reference cell). Fetch lines in the figure are labeled according to wind direction, fetch distance, and wind frequency. Not all fetch lines are drawn in the figure.

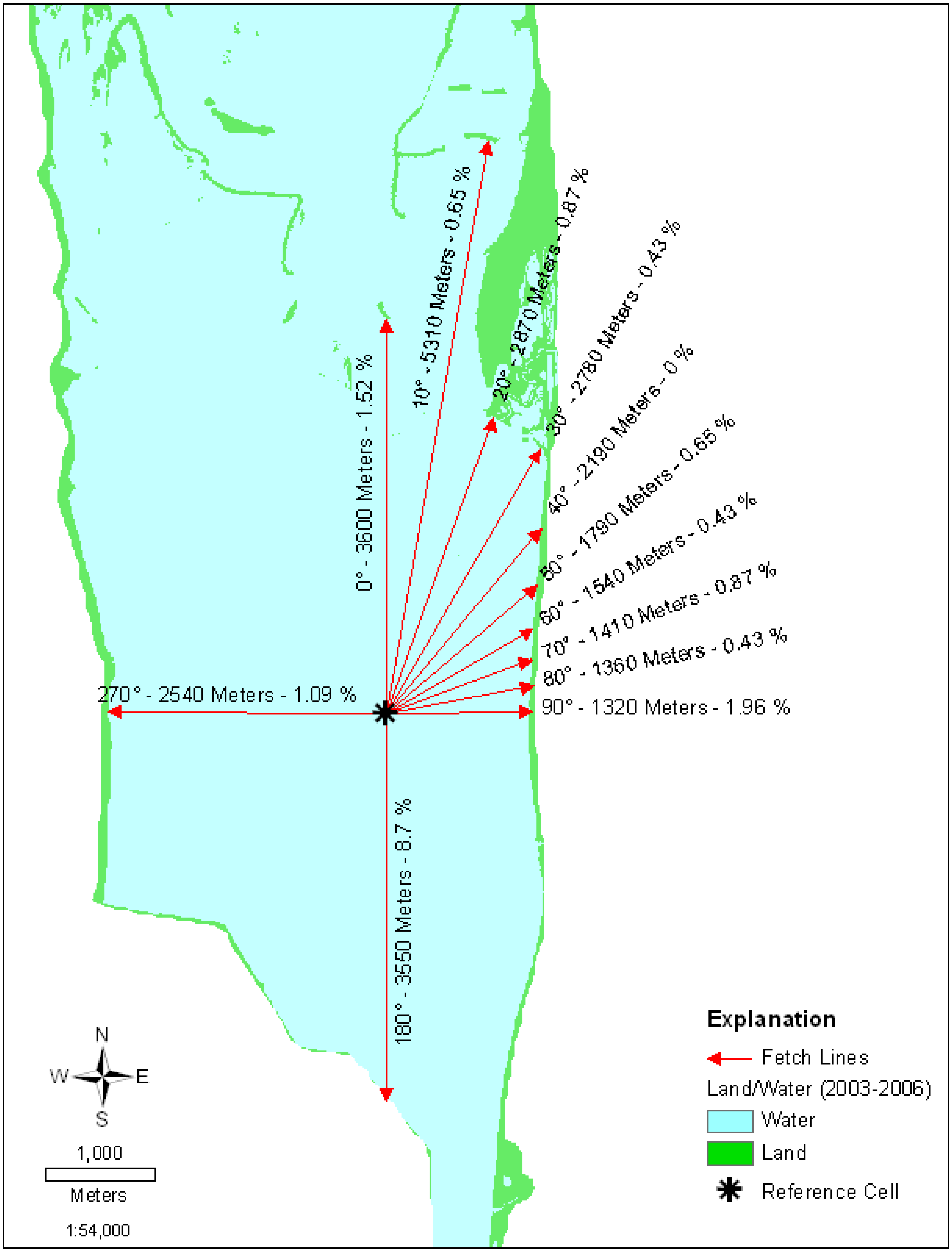

Figure 4. Map depicting methodology for calculation of weighted wind fetch

Results

Weighted wind fetch was calculated for each pool separately using the percent breakdown of wind direction frequencies from Appendix 2 for each pool. Figure 5 gives example output for Pool 13 on the Upper Mississippi River for 1989, 2000, and 2010. Typical of many pools in the upper impounded reach, there is a pronounced area of high fetch at the downstream end of the pool in its impounded area.

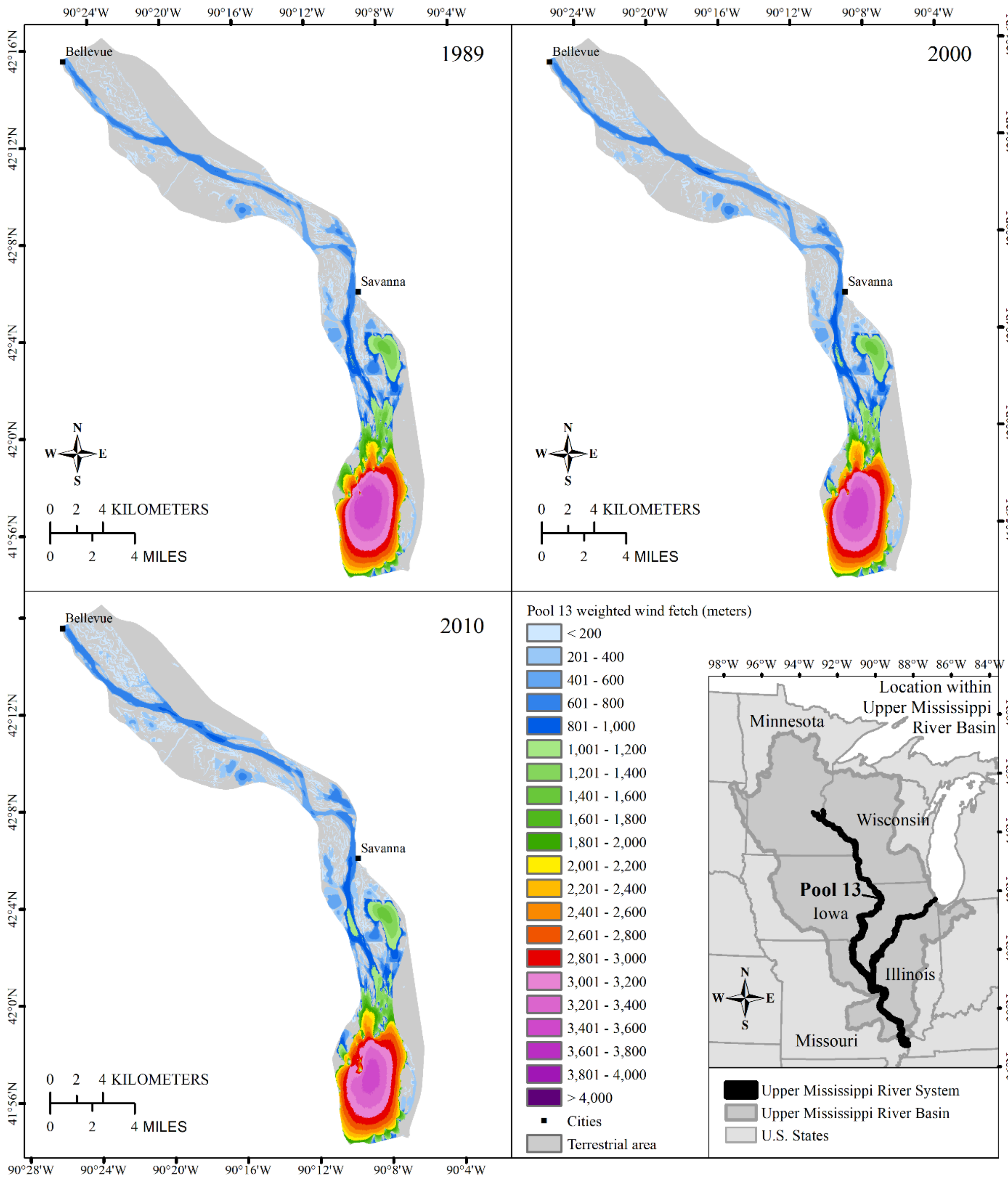

Figure 5. Weighted wind fetch maps for pool 13 on the Upper Mississippi River calculated for 1989, 2000, and 2010.

Several figures were developed to demonstrate the differences in multiple weighted wind fetch characteristics system-wide. The first (Figure 6) shows the maximum weighted wind fetch for each pool. The map depicts the results for 2010/2011 only, whereas the chart at the bottom of the figure shows the data for each time period. The pool outlines in these figures do not represent the actual spatial extent of the floodplain but are provided to better visualize the trends in weighted wind fetch variables being mapped. Figure 7 shows the area in hectares of each pool with weighted wind fetch values greater than 1,000 meters. This figure can identify those pools that have the largest areas within their floodplain with large fetch values. These large fetch areas are of interest to researchers and river managers as they typically are areas where large, potentially destructive wind-driven waves exist. As in the previous figure depicting maximum fetch by pool, this figure also is structured with a map on top showing the results for 2010/2011 and a chart at the bottom depicting the results for each time period. The chart on this figure displays total area of each pool in hectares that has weighted wind fetch greater than 1,000 meters and also the percentage of each pool's aquatic area that has weighted wind fetch greater than 1,000 meters. The last figure in this section (Figure 8) is similar to Figure 7 except the threshold for the largest weighted wind fetch value is 1,500 meters. This was done to further highlight those pools with very large weighted wind fetch values.

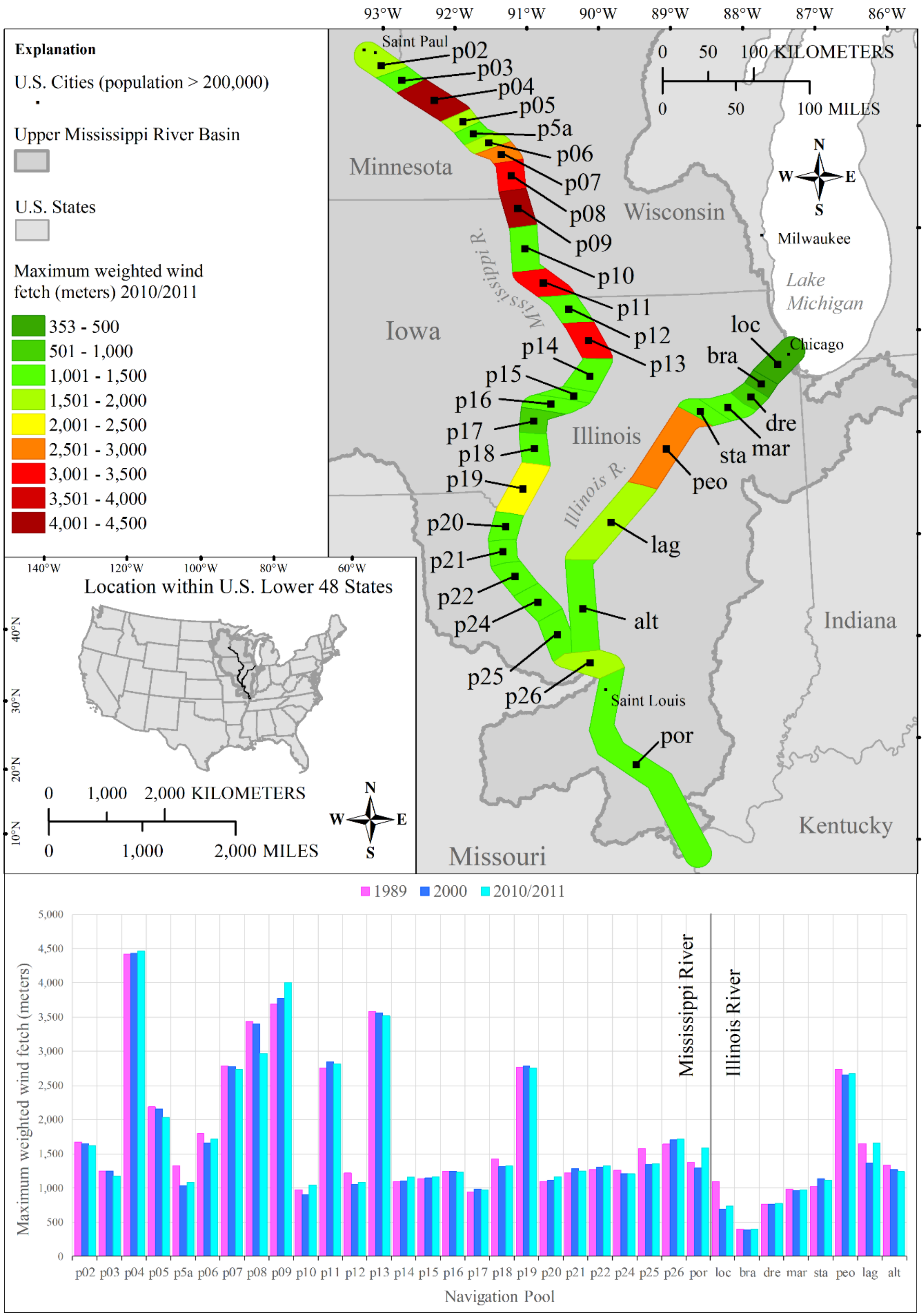

Figure 6. Map and chart depicting the maximum weighted wind fetch values for each pool.

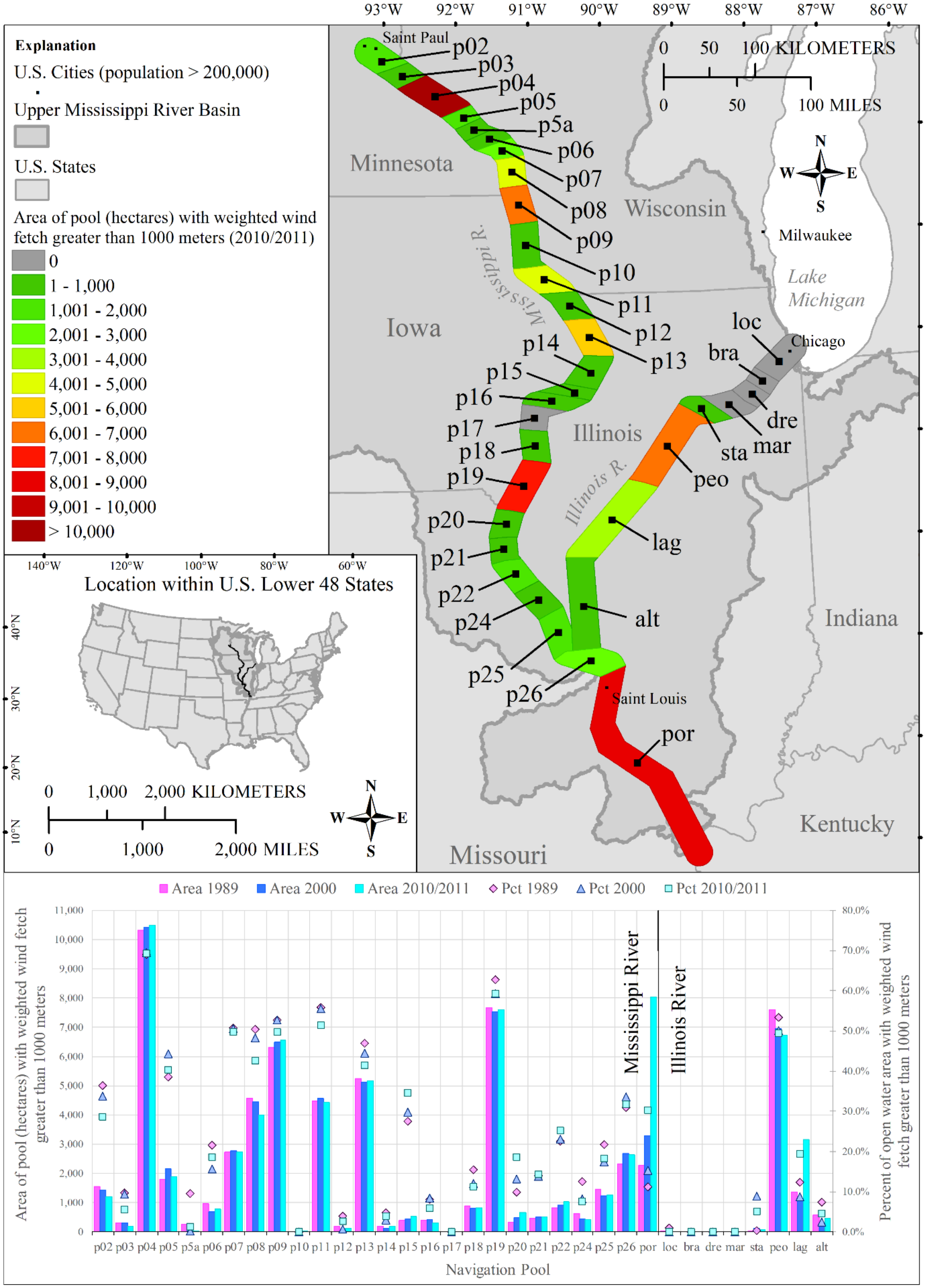

Figure 7. Map and chart depicting the area of each pool with weighted wind fetch greater than 1,000 meters.

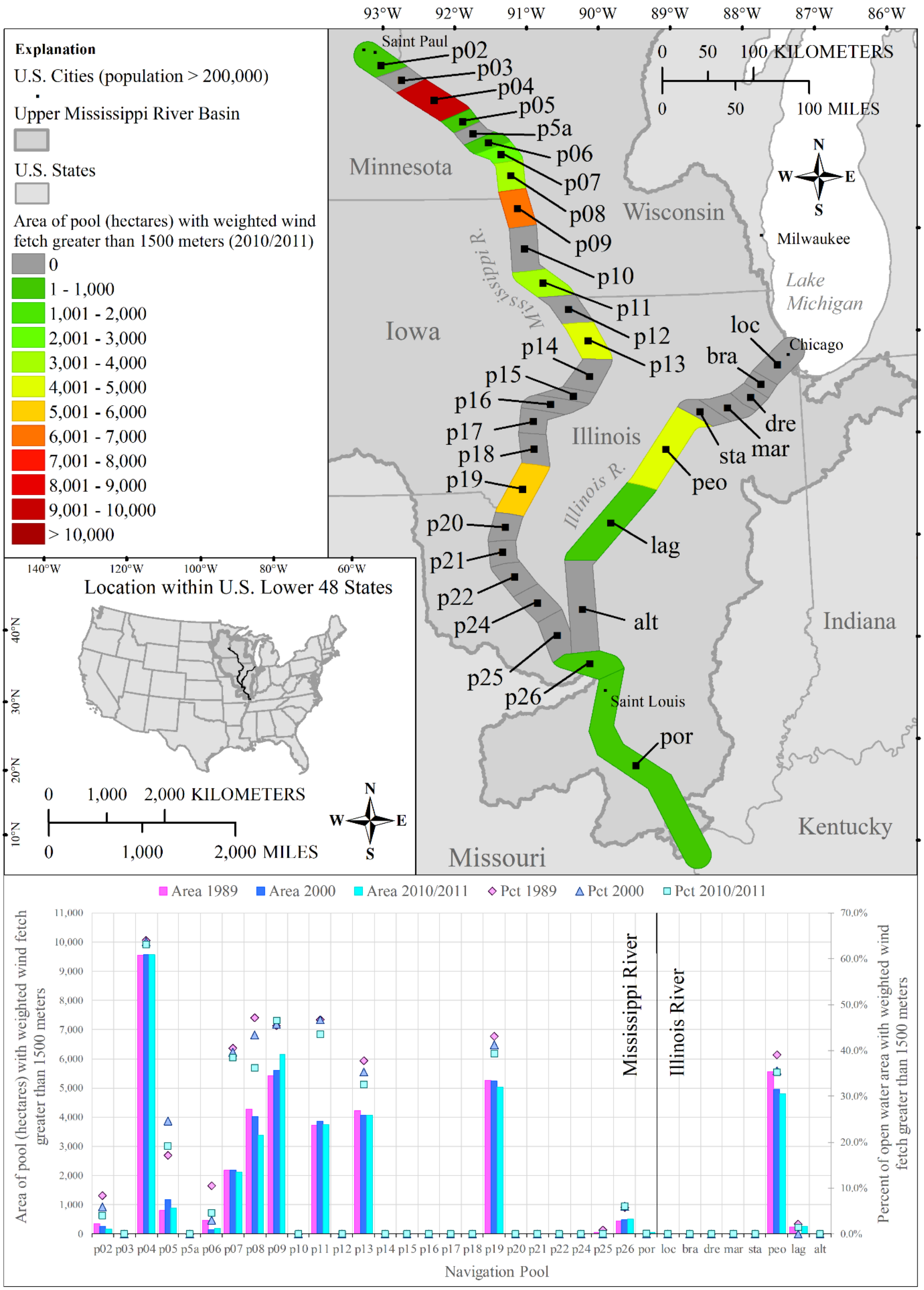

Figure 8. Map and chart depicting the area of each pool with weighted wind fetch greater than 1,500 meters.

The differences in weighted wind fetch between 1989 and 2000, and the differences between 2000 and 2010/2011 were then calculated. This was accomplished using the ArcMap command [Minus] by subtracting the older weighted wind fetch raster from the more recent weighted wind fetch raster (subtracting 1989 from 2000, and then subtracting 2000 from 2010/2011). Figure 9 gives example output for Pool 8 on the Upper Mississippi River comparing 2000 to 2010 and 1989 to 2000.

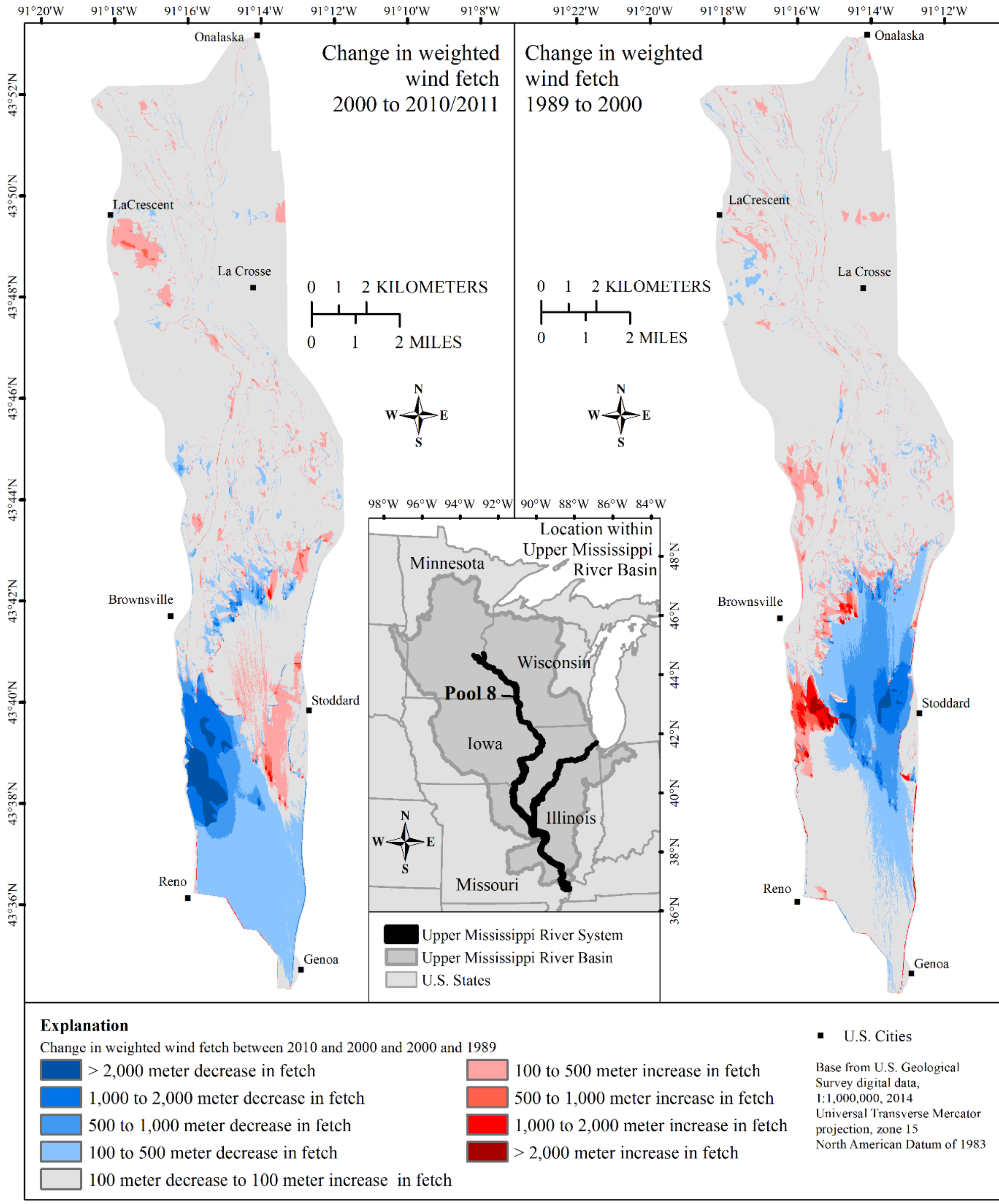

Figure 9. Map depicting the change in fetch for pool 8 on the Upper Mississippi River from 1989 to 2000 and 2000 to 2010.

Figure 10 displays a chart depicting the area (hectares) by pool for each of the different weighted wind fetch change classes when comparing 2000 to 2010/2011. Figure 11 displays the same information this time expressed as the percent of each pool.

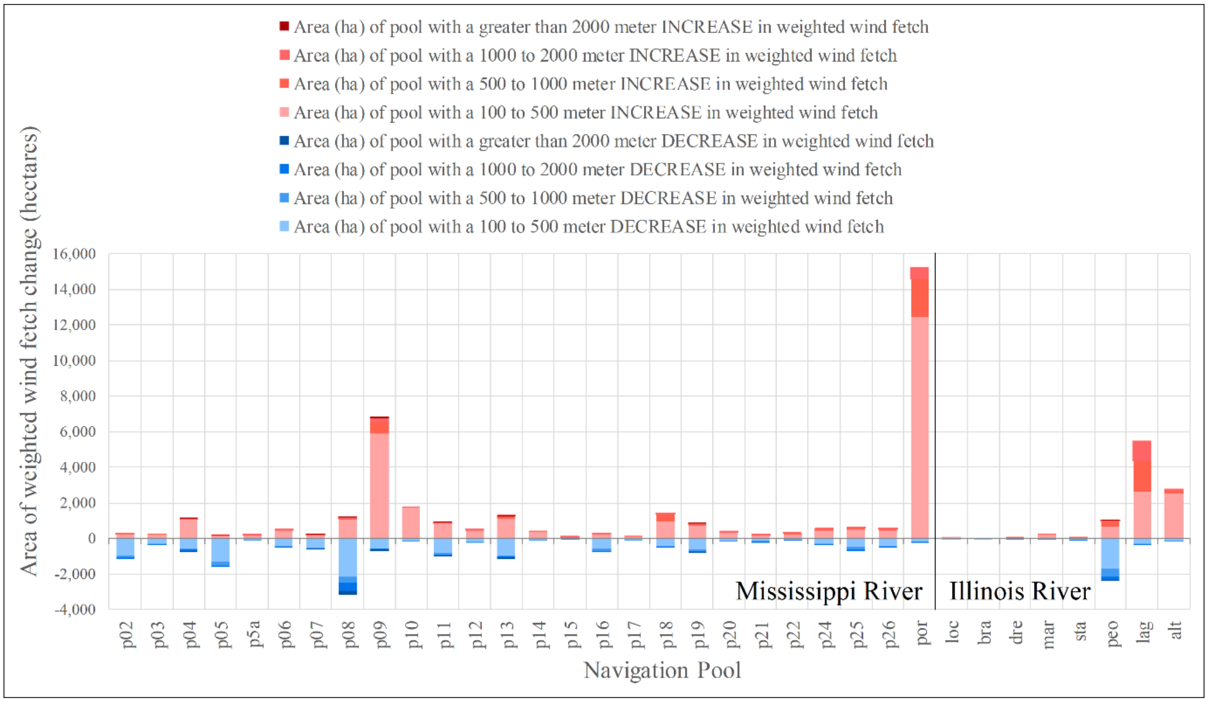

Figure 10. Chart depicting the area (hectares) by pool for each of the different weighted wind fetch change classes when comparing 2000 to 2010/2011

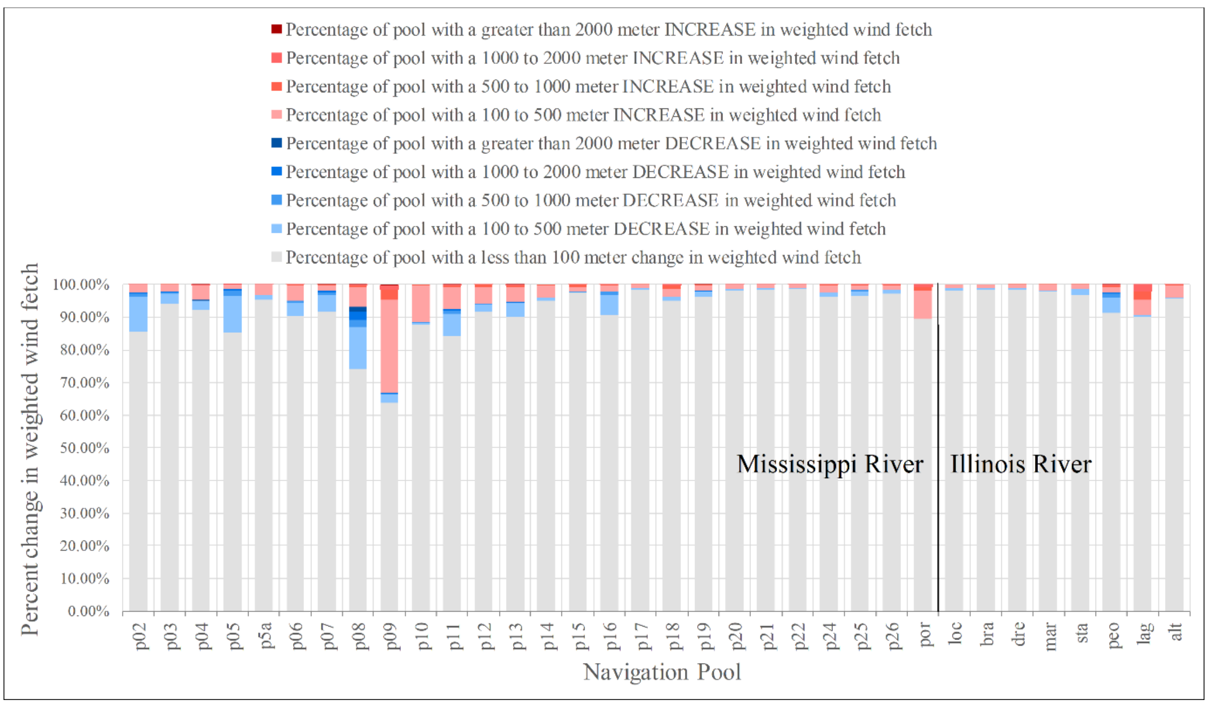

Figure 11. Chart depicting the percent of each pool in each of the different weighted wind fetch change classes when comparing 2000 to 2010/2011

Figure 12 displays a chart depicting the area (hectares) by pool for each of the different weighted wind fetch change classes when comparing 1989 to 2000. Figure 13 displays the same information this time expressed as the percent of each pool.

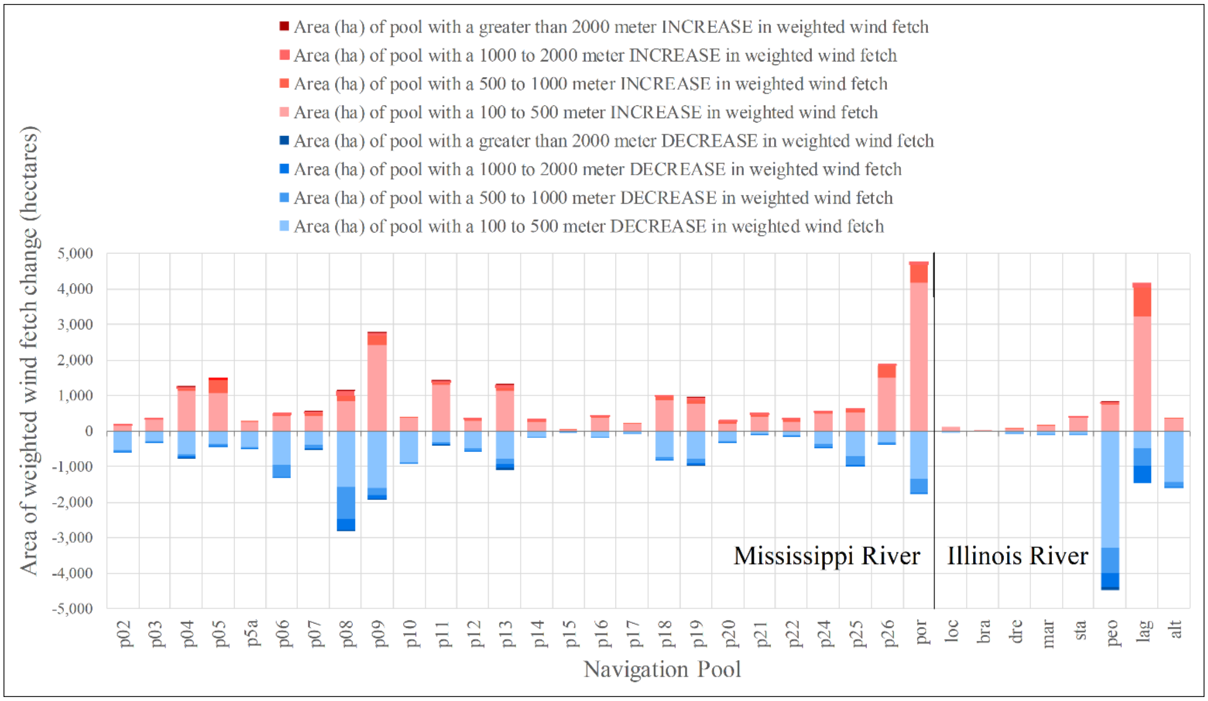

Figure 12. Chart depicting the area (hectares) by pool for each of the different weighted wind fetch change classes when comparing 1989 to 2000.

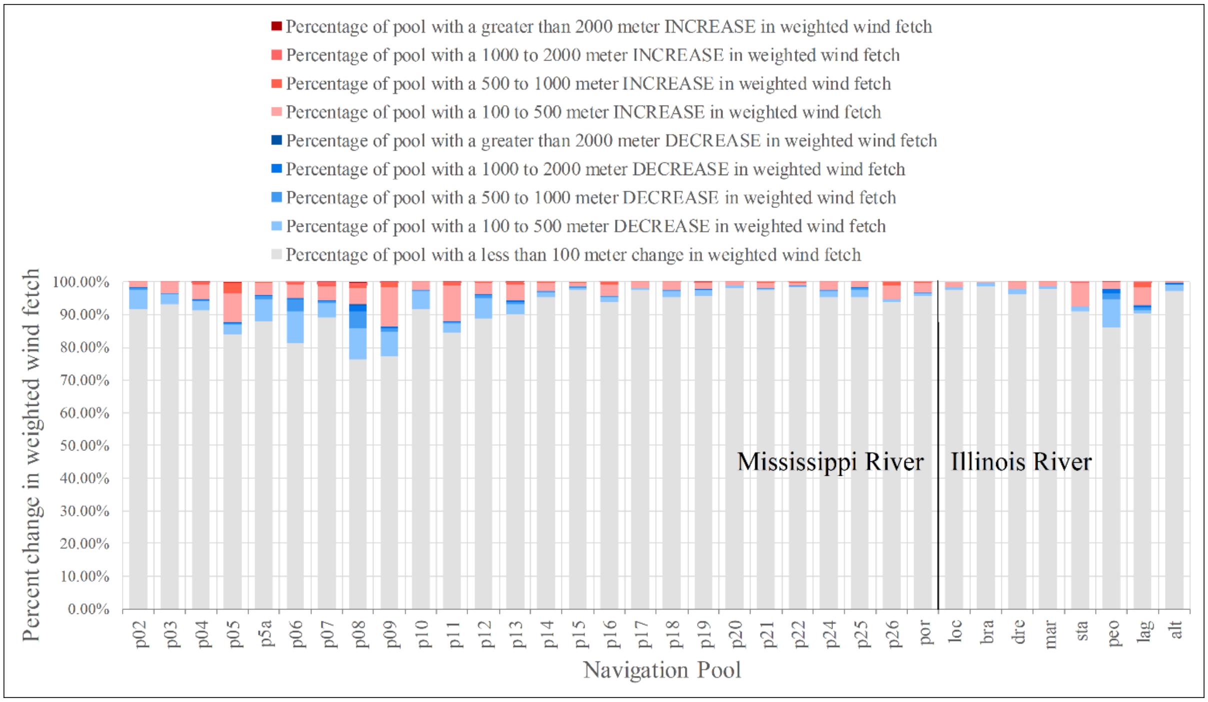

Figure 13. Chart depicting the percent of each pool in each of the different weighted wind fetch change classes when comparing 1989 to 2000.

The spatial datasets developed for this study are available for download from (https://doi.org/10.5066/P99OVGZB; Rohweder and Rogala 2020) and can be viewed spatially within the Upper Mississippi River System – Systemic Spatial Data Viewer (https://umesc.usgs.gov/management/dss/umrs_land_cover_viewer.html).

Discussion

Using this weighted wind fetch analysis approach, it is possible to quantify the amount of weighted wind fetch for each of three time periods where land cover/land use datasets have been developed systemically for the UMRS. By examining these weighted wind fetch products separately by navigation pool, it is possible to distinguish areas within the UMRS that are most at risk for the detrimental effects that can occur due to large weighted wind fetch areas and subsequent destructive wave energy. The figures and associated charts show that the upper impounded reaches of the Mississippi River are most at risk of these destructive waves developing due to the existence of these large fetch areas. Pools 4, 7, 8, 9, 11, and 13 all have maximum weighted wind fetch values above 2,500 meters (Figure 6) for all time periods analyzed. Outside of the upper impounded area, Pool 19 on the lower impounded reach and Peoria Pool on the Illinois River also met this maximum weighted wind fetch value.

By looking at the total area of weighted wind fetch that met a minimum threshold for each pool as in Figures 7 and 8 we see a similar pattern. Pools 4, 8, 9, 11, and 13 on the upper impounded reach, Pool 19 on the lower impounded reach, and again Peoria on the Illinois River reach all have at least 4,000 hectares of aquatic area with at least 1,000 meters of weighted wind fetch for at least one of the time periods (Figure 7). This figure also shows the large increases in weighted wind fetch for the open river reach and the La Grange pool in 2011 due to the high water during aerial photo collection. Only Pool 17 on the lower impounded reach and the Dresden, Brandon, and Lockport pools on the Illinois River reach had zero hectares of aquatic area that met the 1,000 meter weighted wind fetch threshold in 2010/2011, whereas 21 of the 34 pools had zero hectares of aquatic area that met the 1,500 meter weighted wind fetch threshold in 2010/2011 and only pools 19 and 26 on the lower impounded reach and Peoria and La Grange pools on the Illinois River reach had greater than zero hectares that met the 1,500 meter weighted wind fetch threshold (Figure 8). This analysis can be used to target pools where decreases in fetch, typically accomplished using island construction, can help to decrease these large weighted wind fetch values.

In addition to investigating overall summaries of weighted wind fetch by pool, cell-by-cell changes in weighted wind fetch from 1989 to 2000 and from 2000 to 2010/2011 were also examined (Figures 9 – 13). It was discovered that even small variations in river stage height can have a very large effect on the modeled weighted wind fetch values calculated for each pool. Additionally, differences in how the land cover was mapped year-to-year and variations of minimum mapping units, resolution of aerial imagery, and evolving photo-interpretation methods also have a direct effect on how the land cover was mapped from 1989 through 2010/2011 and these small changes can have profound effects on the modeled amount of weighted wind fetch. For this report, only overall area changes were reported. Any detailed investigation of the locations of large changes in weighted wind fetch over time would need to be examined at the local scale and the direct cause of change would need to be determined before any conclusions could be made whether the change was in fact due to some physical process such as erosion, accretion, or construction and not due to differing water levels or mapping inconsistencies.

Acknowledgments

The authors would like to thank Dr. Nathan De Jager (UMESC) for providing thoughtful comments and suggestions on several drafts of this report.

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Appendix 1: Spatial Data Sets Used in Analysis

1989 Land Cover/Land Use Data for the Upper Mississippi River System

Originator

U.S. Army Corps of Engineers' UMRR Program LTRM element (https://doi.org/10.5066/F77M0771)

Abstract

The U.S. Geological Survey Upper Midwest Environmental Sciences Center (UMESC) has created high-resolution land cover/use data sets for the Upper Mississippi River System (UMRS) from 1:15,000-scale color infrared aerial photos collected in 1989. The data are available in two formats. The first used a detailed genus-level classification scheme and was used to classify Mississippi River Navigation Pools 4 through 26, the Open River between Grand Tower and River Mile 32, and the Peoria navigation Pool on the Illinois River. The second classification scheme was developed in 1998 in response to a scientific and programmatic review of the center's mapping projects. This classification scheme identifies plant communities and associations. This second classification scheme was used to interpret data for Mississippi River Pools 1 through 3, the Open River between Lock and Dam 26 and Grand Tower, and the Alton, Starved Rock, Marseilles, Brandon, Dresden, and Lockport navigation pools on the Illinois River. At the time this metadata document was prepared data classified underneath the first classification scheme were being cross-walked to the new scheme. This metadata document has been prepared to document the second classification scheme.

2000 Land Cover/Land Use Data for the Upper Mississippi River System

Originator

U.S. Army Corps of Engineers' UMRR Program LTRM element (https://doi.org/10.5066/F73X85X2)

Abstract

UMESC is in the process of creating high-resolution land cover/use data sets for the UMRS from 1:24,000-scale color infrared aerial photos collected in 2000. The photos are being interpreted using a 1-hectare 10% minimum vegetation cover to delineate land cover/land use, percent vegetation cover, tree height, and hydrology regime. The geographic extent of the UMRS is the Mississippi River from Cairo, Illinois, to Minneapolis, Minnesota, and the Illinois River from its confluence with the Mississippi near Grafton, Illinois, to Lake Michigan.

2010/2011 Land Cover/Land Use Data for the Upper Mississippi River System

Originator

U.S. Army Corps of Engineers' UMRR Program LTRM element (https://doi.org/10.5066/F77942QN)

Abstract

Aerial photographs for Pools 1-13 UMRS and Pools, Alton-Marseilles, Illinois River were collected in color infrared (CIR) in August of 2010 at 8"/pixel and 16"/pixel respectively using a mapping-grade Applanix DSS 439 digital aerial camera. In August 2011, CIR aerial photographs for Pools 14-Open River South, Upper Mississippi River and Pools Dresden-Lockport, Illinois River were collected at 16"/pixel with the same camera. All CIR aerial photos were orthorectified, mosaicked, and compressed. The CIR aerial photos were interpreted and automated using a 31-class LTRMP vegetation classification. The 2010/11 LCU databases were prepared by or under the supervision of competent and trained professional staff using documented standard operated procedures and are subject to rigorous quality control (QC) assurances.

Appendix 2: Percent Breakdown of Wind Direction Frequencies by Pool

The following tables outline the percent frequencies of wind direction measurements for each local climatological data station. These frequencies are displayed as columns with yellow headers. Percent frequencies are also displayed for each pool that falls within each local climatological data station. The pools are labeled with their respective three letter code identified in the section “Analysis Study Area”. The cells within the tables are shaded red according to their percent frequency values, the darker red cells have a higher relative percent frequency. River miles for each pool are calculated using the centroid of each pool. These tables allow the user to visualize the relative percent frequencies of wind directions and compare between pools.

Pools 2 Through 13, Mississippi River

Table 2. Interpolated wind direction percent frequencies calculated for pools 2 through 13 on the Upper Mississippi River.

River Mile	846	828	804	788	773	747	734	729	722	708	702	693	666	632	632	598	572	569	536	533
Wind Direction	Minneapolis St. Paul International Airport, MN, US (MSP)	p02	p03	Red WIng Regional Airport, WI, US (RGK)	p04	p05	p5A	Winona Municipal Max Conrad Field Airport, MN, US (ONA)	p06	p07	La Crosse Municipal Airport, WI, US (LSE)	p08	p09	Prairie Du Chien Municipal Airport, WI, US (PDC)	p10	p11	Dubuque Regional Airport, IA, US (DBQ)	p12	p13	Savanna Tri Township Airport, IL, US (SFY)
0	3.05	2.88	2.66	2.51	2.34	2.05	1.91	1.85	1.97	2.21	2.31	2.20	1.85	1.42	1.42	1.90	2.26	2.27	2.35	2.35
10	2.87	2.59	2.20	1.95	1.81	1.59	1.47	1.43	1.49	1.62	1.67	1.61	1.41	1.15	1.15	1.98	2.62	2.59	2.32	2.30
20	2.37	2.22	2.01	1.88	1.76	1.56	1.46	1.42	1.40	1.37	1.35	1.31	1.17	0.99	0.99	1.93	2.64	2.61	2.27	2.24
30	1.71	1.65	1.57	1.52	1.48	1.42	1.39	1.38	1.28	1.08	0.99	1.00	1.03	1.06	1.06	2.27	3.19	3.14	2.57	2.52
40	1.33	1.40	1.50	1.56	1.50	1.38	1.33	1.31	1.18	0.92	0.81	0.85	0.99	1.16	1.16	2.49	3.50	3.46	3.03	2.99
50	1.49	1.51	1.54	1.55	1.46	1.31	1.23	1.20	1.10	0.89	0.80	0.88	1.12	1.43	1.43	2.37	3.09	3.10	3.23	3.24
60	2.01	1.84	1.62	1.46	1.43	1.37	1.34	1.33	1.26	1.14	1.09	1.20	1.55	1.98	1.98	2.33	2.59	2.66	3.42	3.49
70	2.37	2.25	2.08	1.98	1.82	1.55	1.42	1.36	1.45	1.62	1.69	1.85	2.32	2.92	2.92	2.74	2.60	2.68	3.59	3.67
80	2.42	2.61	2.86	3.03	2.66	2.01	1.69	1.56	1.66	1.84	1.92	2.20	3.03	4.08	4.08	2.97	2.12	2.20	3.11	3.20
90	2.09	2.75	3.63	4.21	3.65	2.67	2.18	2.00	2.04	2.12	2.16	2.62	4.01	5.76	5.76	3.65	2.04	2.09	2.62	2.67
100	2.35	2.96	3.77	4.31	3.98	3.40	3.11	3.00	3.03	3.09	3.12	3.74	5.59	7.93	7.93	4.73	2.29	2.29	2.27	2.27
110	3.08	3.45	3.94	4.27	4.38	4.57	4.66	4.69	4.64	4.53	4.49	4.84	5.88	7.19	7.19	4.33	2.15	2.12	1.79	1.76
120	4.06	4.47	5.01	5.37	5.60	6.01	6.22	6.30	6.03	5.49	5.26	5.16	4.88	4.52	4.52	3.29	2.35	2.33	2.00	1.97
130	5.06	5.81	6.82	7.49	7.19	6.66	6.39	6.29	5.88	5.06	4.70	4.51	3.93	3.20	3.20	2.81	2.51	2.50	2.50	2.49
140	4.97	5.17	5.43	5.61	5.57	5.51	5.48	5.47	5.05	4.22	3.87	3.71	3.22	2.61	2.61	2.58	2.56	2.60	3.12	3.17
150	3.74	3.74	3.73	3.72	3.97	4.39	4.60	4.68	4.47	4.05	3.87	3.60	2.80	1.80	1.80	2.54	3.11	3.18	4.03	4.10
160	3.39	3.31	3.20	3.12	3.05	2.93	2.87	2.84	3.34	4.33	4.76	4.36	3.17	1.66	1.66	2.97	3.96	4.00	4.36	4.40
170	4.25	3.74	3.07	2.62	2.37	1.93	1.71	1.62	2.77	5.06	6.04	5.59	4.25	2.57	2.57	3.24	3.76	3.78	4.03	4.06
180	2.86	2.59	2.22	1.98	1.78	1.44	1.26	1.20	2.52	5.16	6.30	5.85	4.49	2.79	2.79	3.59	4.20	4.08	2.76	2.64
190	2.24	2.13	2.00	1.90	1.75	1.50	1.37	1.32	2.09	3.63	4.29	4.10	3.50	2.76	2.76	3.75	4.51	4.40	3.19	3.08
200	2.18	2.08	1.95	1.86	1.84	1.80	1.78	1.78	1.98	2.38	2.55	2.52	2.43	2.32	2.32	3.72	4.79	4.70	3.67	3.58
210	2.21	2.02	1.76	1.59	1.77	2.07	2.22	2.28	2.15	1.89	1.77	1.79	1.85	1.92	1.92	3.26	4.29	4.19	3.08	2.97
220	2.35	2.02	1.57	1.27	1.56	2.06	2.30	2.40	2.13	1.58	1.35	1.38	1.49	1.62	1.62	2.66	3.46	3.37	2.34	2.25
230	2.03	1.77	1.44	1.21	1.46	1.89	2.11	2.19	1.90	1.32	1.07	1.13	1.32	1.56	1.56	2.11	2.53	2.51	2.28	2.25
240	1.89	1.70	1.45	1.28	1.38	1.55	1.64	1.67	1.49	1.12	0.97	1.05	1.28	1.59	1.59	1.82	2.00	2.03	2.36	2.39
250	2.01	1.91	1.77	1.68	1.54	1.30	1.18	1.14	1.13	1.11	1.11	1.20	1.48	1.83	1.83	1.85	1.87	1.92	2.46	2.51
260	1.87	1.94	2.04	2.11	1.84	1.38	1.15	1.06	1.11	1.22	1.27	1.40	1.79	2.28	2.28	2.01	1.80	1.82	2.08	2.10
270	2.25	2.37	2.53	2.64	2.28	1.65	1.34	1.22	1.30	1.47	1.55	1.73	2.27	2.95	2.95	2.35	1.89	1.93	2.30	2.33
280	2.57	2.88	3.30	3.58	3.11	2.30	1.89	1.74	1.86	2.11	2.22	2.38	2.87	3.48	3.48	2.75	2.19	2.22	2.60	2.64
290	2.81	3.16	3.62	3.93	3.89	3.82	3.79	3.78	3.55	3.09	2.90	2.99	3.27	3.62	3.62	2.93	2.41	2.50	3.50	3.59
300	3.71	3.63	3.51	3.43	3.97	4.92	5.39	5.57	4.95	3.70	3.16	3.27	3.58	3.98	3.98	3.10	2.42	2.50	3.29	3.36
310	3.77	3.53	3.20	2.99	3.66	4.84	5.43	5.65	5.09	3.95	3.46	3.47	3.49	3.52	3.52	3.02	2.65	2.64	2.57	2.57
320	3.62	3.33	2.94	2.69	3.48	4.86	5.55	5.81	5.28	4.20	3.74	3.68	3.48	3.24	3.24	2.88	2.61	2.58	2.35	2.32
330	3.08	2.92	2.72	2.58	3.26	4.43	5.02	5.25	4.92	4.25	3.97	3.87	3.58	3.21	3.21	2.76	2.42	2.41	2.31	2.30
340	2.89	2.74	2.55	2.41	2.75	3.33	3.62	3.74	3.79	3.91	3.96	3.73	3.07	2.23	2.23	2.27	2.30	2.29	2.14	2.13
350	3.03	2.93	2.80	2.71	2.65	2.55	2.51	2.49	2.74	3.26	3.48	3.25	2.57	1.70	1.70	2.05	2.32	2.30	2.11	2.10
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Pools 14 Through Open River, Mississippi River

Table 3. Interpolated wind direction percent frequencies calculated for pools 14 through the open river reach on the Upper Mississippi River.

River Mile	533	510	487	484	472	450	448	424	401	391	368	352	335	312	310	287	258	223	217	195	97.5	0
Wind Direction	Savanna Tri Township Airport, IL, US (SFY)	p14	p15	Moline Quad City International Airport, IL, US (MLI)	p16	Muscatine Municipal Airport, IA, US (MUT)	p17	p18	Burlington Municipal Airport, IA, US (BRL)	p19	Keokuk Municipal Airport, IA, US (EOK)	p20	p21	Hannibal Regional Airport, MO, US (HAE)	p22	p24	p25	p26	St Charles Co Airport, MO, US (SET)	Cahokia St Louis Downtown Airport, IL, US (CPS)	por	Cairo Regional Airport, IL, US (CIR)
0	2.35	1.89	1.43	1.37	1.61	2.05	2.06	2.18	2.30	2.25	2.13	2.04	1.93	1.80	1.81	1.96	2.15	2.38	2.42	2.66	2.63	2.60
10	2.30	1.91	1.52	1.47	1.65	1.97	1.96	1.89	1.81	1.77	1.66	1.62	1.58	1.53	1.54	1.73	1.95	2.23	2.28	2.30	2.36	2.41
20	2.24	1.93	1.62	1.58	1.74	2.03	2.02	1.92	1.82	1.68	1.36	1.36	1.37	1.37	1.40	1.66	1.99	2.39	2.45	2.17	2.37	2.57
30	2.52	2.06	1.60	1.54	1.75	2.12	2.11	2.01	1.91	1.82	1.63	1.48	1.33	1.13	1.15	1.45	1.82	2.27	2.34	2.11	2.42	2.72
40	2.99	2.32	1.64	1.56	1.83	2.32	2.32	2.27	2.22	1.99	1.47	1.40	1.33	1.24	1.27	1.55	1.91	2.34	2.41	2.19	2.28	2.36
50	3.24	2.66	2.07	1.99	2.14	2.40	2.40	2.47	2.54	2.34	1.90	1.76	1.60	1.39	1.42	1.69	2.03	2.45	2.52	1.52	1.70	1.88
60	3.49	3.13	2.78	2.73	2.62	2.41	2.41	2.44	2.47	2.44	2.37	2.19	1.99	1.73	1.74	1.97	2.25	2.59	2.64	1.42	1.66	1.90
70	3.67	3.56	3.46	3.44	3.02	2.24	2.24	2.26	2.27	2.36	2.57	2.42	2.25	2.03	2.05	2.25	2.51	2.82	2.88	1.44	1.61	1.78
80	3.20	3.92	4.64	4.74	3.91	2.40	2.39	2.35	2.31	2.41	2.64	2.51	2.37	2.18	2.21	2.51	2.88	3.33	3.41	1.39	1.46	1.52
90	2.67	3.82	4.97	5.12	4.23	2.60	2.59	2.53	2.48	2.43	2.31	2.32	2.33	2.35	2.38	2.68	3.07	3.53	3.61	1.47	1.39	1.31
100	2.27	3.17	4.08	4.20	3.53	2.30	2.31	2.38	2.45	2.51	2.66	2.61	2.56	2.49	2.52	2.91	3.39	3.97	4.07	1.53	1.54	1.55
110	1.76	2.26	2.76	2.82	2.55	2.06	2.07	2.22	2.37	2.47	2.71	2.61	2.50	2.35	2.38	2.72	3.14	3.65	3.74	1.83	1.65	1.46
120	1.97	2.16	2.35	2.38	2.35	2.28	2.28	2.20	2.13	2.46	3.22	3.08	2.92	2.71	2.72	2.75	2.80	2.86	2.87	2.29	1.96	1.63
130	2.49	2.36	2.22	2.20	2.39	2.73	2.71	2.42	2.14	2.58	3.59	3.41	3.22	2.97	2.96	2.84	2.69	2.50	2.47	3.04	2.57	2.10
140	3.17	2.87	2.57	2.53	2.64	2.84	2.83	2.75	2.68	2.98	3.69	3.64	3.58	3.50	3.48	3.21	2.87	2.46	2.39	3.87	3.19	2.51
150	4.10	3.61	3.13	3.06	3.52	4.35	4.30	3.75	3.21	3.29	3.47	3.74	4.03	4.41	4.37	3.94	3.40	2.74	2.63	6.68	5.12	3.57
160	4.40	3.80	3.19	3.11	3.78	5.00	4.94	4.28	3.64	3.52	3.24	3.77	4.33	5.10	5.05	4.52	3.86	3.05	2.92	8.35	6.74	5.13
170	4.06	3.60	3.14	3.08	3.77	5.04	5.00	4.58	4.17	3.81	2.99	3.56	4.16	4.97	4.95	4.62	4.22	3.73	3.65	7.38	6.63	5.88
180	2.64	2.97	3.30	3.34	3.61	4.10	4.14	4.59	5.02	4.65	3.78	4.08	4.39	4.81	4.79	4.52	4.18	3.76	3.69	5.26	5.55	5.83
190	3.08	3.21	3.34	3.36	3.47	3.68	3.77	4.84	5.85	5.84	5.82	5.56	5.29	4.92	4.89	4.61	4.25	3.81	3.74	4.14	5.60	7.05
200	3.58	3.90	4.21	4.26	4.00	3.53	3.62	4.72	5.77	5.54	5.02	4.85	4.67	4.43	4.40	4.08	3.68	3.19	3.11	3.41	5.25	7.09
210	2.97	3.25	3.53	3.57	3.34	2.91	2.95	3.50	4.02	4.20	4.59	4.48	4.35	4.19	4.16	3.85	3.46	2.98	2.90	2.71	4.13	5.56
220	2.25	2.58	2.90	2.95	2.71	2.29	2.33	2.83	3.30	3.51	3.98	3.79	3.58	3.30	3.29	3.13	2.92	2.67	2.63	2.24	3.29	4.34
230	2.25	2.40	2.54	2.56	2.41	2.13	2.14	2.23	2.31	2.52	2.99	2.85	2.71	2.51	2.51	2.56	2.63	2.70	2.72	2.09	2.49	2.89
240	2.39	2.60	2.81	2.84	2.58	2.11	2.11	2.21	2.31	2.39	2.59	2.51	2.43	2.32	2.32	2.31	2.30	2.28	2.28	2.38	2.33	2.28
250	2.51	2.72	2.92	2.95	2.56	1.84	1.84	1.90	1.94	2.05	2.28	2.31	2.33	2.37	2.37	2.37	2.37	2.37	2.37	2.18	2.15	2.13
260	2.10	2.23	2.35	2.37	2.30	2.19	2.17	1.94	1.72	1.83	2.09	2.16	2.23	2.33	2.32	2.28	2.23	2.16	2.15	1.85	1.82	1.79
270	2.33	2.56	2.79	2.82	2.66	2.35	2.32	2.00	1.68	1.81	2.09	2.13	2.16	2.21	2.22	2.33	2.46	2.63	2.65	1.74	1.73	1.73
280	2.64	3.05	3.47	3.53	3.25	2.76	2.72	2.25	1.80	1.86	2.00	2.08	2.15	2.26	2.26	2.37	2.51	2.67	2.70	1.72	1.65	1.58
290	3.59	3.41	3.23	3.21	3.20	3.19	3.15	2.61	2.10	2.11	2.14	2.22	2.32	2.44	2.45	2.54	2.65	2.79	2.81	2.14	1.78	1.43
300	3.36	3.42	3.47	3.47	3.47	3.46	3.42	3.00	2.59	2.53	2.41	2.53	2.66	2.84	2.85	2.89	2.94	3.00	3.02	2.24	1.89	1.55
310	2.57	2.76	2.95	2.98	3.25	3.74	3.72	3.42	3.14	3.01	2.72	2.68	2.63	2.58	2.58	2.64	2.70	2.79	2.80	2.23	1.91	1.59
320	2.32	2.37	2.42	2.43	2.62	2.97	2.99	3.19	3.39	3.23	2.84	2.85	2.86	2.87	2.86	2.74	2.58	2.39	2.36	2.10	1.90	1.71
330	2.30	2.07	1.83	1.80	2.14	2.76	2.76	2.80	2.84	2.78	2.64	2.70	2.76	2.85	2.84	2.67	2.46	2.21	2.17	2.04	1.99	1.95
340	2.13	1.82	1.52	1.48	1.92	2.72	2.72	2.74	2.75	2.55	2.10	2.36	2.64	3.02	3.00	2.78	2.50	2.16	2.11	2.73	2.40	2.07
350	2.10	1.65	1.21	1.15	1.50	2.14	2.16	2.35	2.54	2.46	2.30	2.36	2.42	2.50	2.49	2.40	2.28	2.13	2.10	3.15	2.86	2.56
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Lockport Through Alton Pool, Illinois River

Table 4. Interpolated wind direction percent frequencies calculated for pools on the Illinois River.

River Mile	316	303	293	289	283	278	263	259	239	220	189	188	159	110	56	47	0
Wind Direction	Chicago Midway Airport, IL, US (MDW)	loc	Romeoville Weather Forecast Office, IL, US (LOT)	bra	Joliet, IL, US (JOT)	dre	Morris Municipal Jr Washburn Field Airport, IL, US (C09)	mar	sta	Peru IL Valley Regional Walter A Duncan Field Airport, IL, US (VYS)	peo	Lacon Marshall Co Airport, IL, US (C75)	Peoria International Airport, IL, US (PIA)	lag	Pittsfield Penstone Municipal Airport, IL, US (PPQ)	alt	St Charles Co Airport, MO, US (SET)
0	2.90	2.09	1.46	1.86	2.45	2.08	0.94	1.01	1.37	1.72	2.50	2.53	1.33	1.73	2.16	2.21	2.42
10	3.77	2.48	1.49	1.99	2.73	2.32	1.11	1.18	1.55	1.90	1.89	1.89	1.61	1.72	1.83	1.90	2.28
20	3.97	2.73	1.79	2.48	3.52	3.07	1.73	1.72	1.69	1.67	1.50	1.49	1.57	1.53	1.49	1.64	2.45
30	4.58	3.62	2.88	3.45	4.29	3.69	1.86	1.86	1.87	1.87	1.61	1.61	1.77	1.88	2.00	2.05	2.34
40	3.39	3.66	3.87	4.25	4.84	4.15	2.08	2.13	2.38	2.61	1.93	1.91	2.33	2.34	2.35	2.36	2.41
50	2.75	3.26	3.64	3.82	4.08	3.75	2.77	2.79	2.88	2.97	2.38	2.36	3.33	2.84	2.31	2.34	2.52
60	3.12	4.21	5.04	4.30	3.18	3.33	3.78	3.73	3.50	3.28	2.75	2.73	3.64	2.92	2.12	2.21	2.64
70	3.22	4.01	4.62	3.92	2.87	3.18	4.09	4.05	3.84	3.64	2.70	2.67	4.12	3.10	1.98	2.13	2.88
80	3.92	4.00	4.06	3.41	2.42	2.59	3.10	3.20	3.71	4.20	2.88	2.84	3.63	2.72	1.72	2.00	3.41
90	3.80	3.24	2.81	2.63	2.35	2.44	2.72	2.75	2.91	3.05	2.93	2.92	3.02	2.42	1.77	2.06	3.61
100	2.92	2.54	2.25	2.22	2.17	2.19	2.26	2.28	2.43	2.57	2.78	2.78	2.09	2.02	1.94	2.28	4.07
110	2.12	1.94	1.80	2.05	2.42	2.42	2.44	2.44	2.46	2.48	2.44	2.44	1.70	1.91	2.14	2.40	3.74
120	1.66	1.63	1.61	1.96	2.48	2.45	2.38	2.38	2.39	2.39	1.91	1.89	1.65	2.05	2.50	2.56	2.87
130	1.52	1.57	1.61	1.86	2.24	2.31	2.53	2.48	2.25	2.03	2.46	2.48	1.68	2.33	3.04	2.94	2.47
140	1.63	1.91	2.12	2.27	2.49	2.47	2.42	2.40	2.29	2.19	2.90	2.92	2.13	2.86	3.67	3.46	2.39
150	1.30	2.05	2.62	2.63	2.64	2.67	2.75	2.71	2.49	2.29	2.99	3.01	2.33	3.15	4.04	3.81	2.63
160	1.97	2.64	3.15	2.98	2.72	2.89	3.39	3.29	2.82	2.37	3.39	3.42	2.51	3.31	4.19	3.98	2.92
170	2.62	3.09	3.46	3.42	3.36	3.45	3.69	3.63	3.31	3.00	4.26	4.30	3.86	4.47	5.15	4.91	3.65
180	3.06	2.92	2.82	2.99	3.24	3.12	2.77	2.81	3.05	3.27	4.07	4.10	5.82	5.48	5.11	4.88	3.69
190	3.78	3.45	3.21	3.54	4.03	3.88	3.45	3.54	3.96	4.36	4.17	4.16	6.08	5.52	4.91	4.72	3.74
200	4.39	3.87	3.47	3.76	4.19	3.99	3.42	3.45	3.63	3.79	4.76	4.79	5.43	4.68	3.85	3.73	3.11
210	4.59	4.21	3.93	3.94	3.96	4.04	4.28	4.20	3.79	3.40	5.35	5.41	4.37	3.80	3.17	3.13	2.90
220	3.50	3.79	4.02	3.59	2.94	3.11	3.61	3.57	3.39	3.21	4.43	4.47	3.86	3.38	2.85	2.82	2.63
230	3.19	3.18	3.17	3.01	2.76	2.79	2.88	2.99	3.51	4.00	3.00	2.97	3.24	3.11	2.96	2.92	2.72
240	3.60	3.22	2.93	3.02	3.16	3.19	3.27	3.29	3.41	3.53	2.64	2.61	2.73	2.81	2.89	2.79	2.28
250	3.18	2.94	2.76	2.81	2.90	2.94	3.07	3.06	3.00	2.95	2.00	1.96	1.96	2.31	2.69	2.64	2.37
260	2.65	2.95	3.19	2.95	2.60	2.70	2.99	2.96	2.81	2.67	2.14	2.12	1.99	2.30	2.64	2.56	2.15
270	2.58	2.96	3.25	3.09	2.84	3.04	3.67	3.60	3.28	2.97	1.95	1.92	2.23	2.30	2.39	2.43	2.65
280	2.59	2.86	3.07	2.80	2.40	2.83	4.13	4.06	3.69	3.35	2.11	2.07	2.50	2.49	2.49	2.52	2.70
290	2.34	2.48	2.59	2.32	1.93	2.28	3.35	3.35	3.34	3.33	2.37	2.34	2.55	2.84	3.16	3.11	2.81
300	2.18	2.44	2.63	2.14	1.40	1.83	3.13	3.14	3.22	3.29	2.55	2.52	3.34	3.20	3.03	3.03	3.02
310	1.50	1.87	2.15	1.86	1.41	1.76	2.80	2.79	2.71	2.64	2.82	2.83	2.58	2.61	2.63	2.66	2.80
320	1.46	1.76	1.99	1.78	1.46	1.64	2.19	2.18	2.15	2.12	2.56	2.58	1.92	2.18	2.46	2.44	2.36
330	1.40	1.60	1.76	1.70	1.60	1.71	2.01	1.99	1.88	1.77	2.35	2.37	1.76	1.98	2.23	2.22	2.17
340	1.26	1.37	1.46	1.67	1.99	1.92	1.73	1.73	1.70	1.67	2.36	2.38	1.79	1.94	2.11	2.11	2.11
350	1.61	1.45	1.32	1.57	1.95	1.76	1.20	1.23	1.36	1.48	2.18	2.21	1.54	1.77	2.03	2.04	2.10
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100