



**State and Private Forestry  
Michigan Forest Resource Assessment and Strategy  
(Michigan's Forest Action Plan)**

**Mid-Term (Five-Year) Review**

**Forest Resources Division**

### **MICHIGAN DEPARTMENT OF NATURAL RESOURCES MISSION STATEMENT**

"The Michigan Department of Natural Resources is committed to the conservation, protection, management, use and enjoyment of the State's natural and cultural resources for current and future generations."

### **NATURAL RESOURCES COMMISSION STATEMENT**

The Natural Resources Commission, as the governing body for the Michigan Department of Natural Resources, provides a strategic framework for the DNR to effectively manage your resources. The NRC holds monthly, public meetings throughout Michigan, working closely with its constituencies in establishing and improving natural resources management policy.

The Michigan Department of Natural Resources provides equal opportunities for employment and access to Michigan's natural resources. Both State and Federal laws prohibit discrimination on the basis of race, color, national origin, religion, disability, age, sex, height, weight or marital status under the U.S. Civil Rights Acts of 1964 as amended, 1976 MI PA 453, 1976 MI PA 220, Title V of the Rehabilitation Act of 1973 as amended, and the 1990 Americans with Disabilities Act, as amended.

If you believe that you have been discriminated against in any program, activity, or facility, or if you desire additional information, please write: Human Resources, Michigan Department of Natural Resources, PO Box 30028, Lansing MI 48909-7528, or Michigan Department of Civil Rights, Cadillac Place, 3054 West Grand Blvd, Suite 3-600, Detroit, MI 48202, or Division of Federal Assistance, U.S. Fish and Wildlife Service, 4401 North Fairfax Drive, Mail Stop MBSP-4020, Arlington, VA 22203

For information or assistance on this publication, contact the Forest Resources Division, Michigan Department of Natural Resources, P.O. Box 30452, Lansing, MI 48909-7952.

This publication is available in alternative formats upon request.

## Table of Contents

<b>BACKGROUND</b> .....	1
<b>SUMMARY OF PROGRESS AND HIGHLIGHTS FROM FIRST FIVE-YEARS</b> .....	1
Forest Stewardship .....	1
Urban and Community Forestry .....	1
Forest Legacy.....	2
Forest/Community Wildfire Protection.....	2
Forest Health .....	2
State Forest Management Plan .....	3
Wildlife Action Plan .....	3
State Comprehensive Outdoor Recreation Plan (2013 – 2017).....	3
<b>CHALLENGES IN IMPLEMENTATION</b> .....	4
Forest Stewardship .....	4
Urban and Community Forest .....	4
Forest Legacy.....	4
Forest/Community Wildfire Protection.....	4
Forest Health .....	5
State Forest Management Planning .....	5
Wildlife Action Plan .....	5
Statewide Comprehensive Outdoor Recreation Plan (2013-2017).....	5
<b>PRIORITIES FOR IMPLEMENTATION OVER NEXT FIVE-YEARS</b> .....	5
Forest Stewardship .....	5
Urban and Community Forest .....	6
Forest Legacy.....	6
Forest/Community Wildfire Protection.....	6
Forest Health .....	6
State Forest Management Planning .....	7
Wildlife Action Plan .....	7
Statewide Comprehensive Outdoor Recreation Plan (2013-2017).....	7
<b>OPPORTUNITIES FOR IMPROVEMENT IN THE 2020-2030 FOREST ACTION PLAN FOR MICHIGAN</b> .....	7
Vision .....	7
Priorities.....	7
Goals, Objectives and Targets .....	8
Landscape Assessment .....	8
Climate Change .....	8
Focus.....	8
Short-Term Revisions.....	8
Stakeholder Consultation .....	8
Data Gaps and Potential Research Areas .....	9
Research Needs .....	9

## I. BACKGROUND

The 2008 Farm Bill required states to complete a statewide assessment and forest resource strategy by June of 2010. The strategy identified priorities to be addressed over the 10-year period from 2010 to 2020. There was also a requirement to review progress at the mid-term or five-year mark and potentially make revision to the strategy. This report addresses the five-year review of *Michigan's Forest Resource Assessment and Strategy* which represents Michigan's Forest Action Plan.

## II. SUMMARY OF PROGRESS AND HIGHLIGHTS FROM FIRST FIVE-YEARS

### Forest Stewardship

- There have been many highlights in the Michigan Forest Stewardship Program (FSP) in the first five years of the Forest Action Plan.
- The core purpose of the Michigan FSP is to help landowners manage, protect, and *enjoy* their forest. The mission of the Michigan FSP is to partner with U.S. Forest Service, other state and federal government agencies, private organizations, professional land managers and forest landowners to develop and implement outstanding Forest Stewardship Plans for owners of private and municipal forest land.
- The vision of the Michigan FSP is to provide ALL forest landowners in Michigan with information and resources that are rooted in both forestry science and environmental ethics so that they can maximize their enjoyment of their forests, sustainably manage their forests to protect the ecology of their land, optimize their economic returns from their investment of time and capital and improve the forests of Michigan for the following generations. The values of the Michigan FSP include partnerships, flexibility, customer service and continual improvement.
- There are approximately 400,000 non-industrial private forest owners in Michigan who together own more than 9 million acres of forest land. The Michigan FSP has developed nearly 5,300 Forest Stewardship Plans since 1991, covering 850,000 acres of forest land. The program develops an average of 215 Forest Stewardship Plans each year covering 34,320 total planned acres. Professional planning is delivered through the Forest Stewardship Coordinator and three Forest Service foresters in partnership with 122 certified plan writers, who include both professional foresters and wildlife biologists in the private sector. The Michigan FSP has doubled the number of trained and certified plan writers in just the past 18 months. The program seeks to increase the number of annual plans and acres.

### Urban and Community Forestry

- In 2010, the Urban and Community Forestry Program (UCFP) worked with multiple stakeholders in developing the initial issues, goals and actions that were incorporated into the Michigan's Forest Resource Assessment and Strategy. Since its adoption, the document has largely been a static reference of the issues and goals set forth at that time. The UCFP coordinator has not sought further input or advice from stakeholders in anticipation that it would be revisited in 2015 for possible revisions.
- In terms of highlights, the Forest Resource Assessment and Strategy has been used to effectively target key issues and priority areas related to urban and community forestry. Specifically, it has helped improve engagement with partners by articulating issues, outlining goals and actions and providing opportunities to collaborate on grant proposals to

address them. Sixty-six federal Great Lakes Restoration Initiative and 34 Landscape Scale Restoration grant program related proposals were submitted and awarded from 2010-2014 through the UCFP.

### **Forest Legacy**

- Over the past five years, Michigan's Forest Legacy Program (FLP) has been successful in not only completing long-term projects, but also gaining support and funding for additional projects. The final phase, consisting of over 30,000 acres, of the Northern Great Lakes Forest project, was completed in September of 2010. This final phase brought to a conclusion the entire Northern Great Lakes Forest project, which protects and ensures long-term sustainable forest management on over 150,000 acres stretching across the Upper Peninsula. In late 2012, Michigan successfully completed the fee acquisition of the Crisp Point property, also in the Upper Peninsula. The Crisp Point property includes over 2½ miles of Lake Superior shoreline and 3,810 acres of forest land. In fiscal year 2013, Michigan was also successful in gaining FLP grant funding for the Gitcha-ninj Nebish Forest project in the northwest Lower Peninsula. This 750-acre conservation easement acquisition was finalized in the summer of 2015.

### **Forest/Community Wildfire Protection**

- Since 2010, the Community Wildfire Protection Program (CWPP) has completed eleven new protection plans in high risk counties and townships across the state. Two more grants have been issued for counties to develop new wildfire protection plans, and three grants were issued to counties with plans in place to complete mitigation work identified in their original grants. The program also placed five electronic Smokey Bear Fire Danger signs in Michigan Department of Transportation rest areas along major freeways and highways across the state to inform the traveling public of current fire danger and threats. Two more placements are scheduled for 2015. Opportunities to expand fire prevention efforts across the state by contracting with a media-buying company to leverage prevention messages on radio, television, billboards, newspapers, and other various digital/social media venues, have all received support from our cooperators at the local, state and federal level, to boost the amount of resources available for the annual prevention efforts. Additionally, there has been great cooperation, expansion and enhancement of our relationships with the National Weather Service. They provide relevant weather data relating to fire weather, spot forecast, short- and long-term fire weather predictions, onsite training and weather presentations at statewide tactical meetings, as well as on site participation and observation at various prescribe burns.

### **Forest Health**

- The discovery of emerald ash borer in Michigan in 2002 triggered a dramatic and permanent shift in program focus and priorities by the forest health community. The impacts of this and other exotic forest invasives on the state's forest resource – both rural and urban – has forced a reassessment of response strategies, management recommendations and outreach activities. In the past five years, the Michigan Department of Natural Resources (MDNR), Forest Resources Division (FRD), Forest Health Program's activities have been based on the goal of 'Early Detection, Rapid Response,' a nationwide initiative designed to identify invasive organisms early and to reduce resource impacts. Highlights include:
  - Hiring a full-time forest health field technician. This position has been instrumental in our ability to identify, detect, monitor and manage insects and diseases in urban and rural forests on state, federal and private lands across Michigan.

- Development of interagency cooperatives that pool resources between state and federal agencies and universities. For example, the Interagency Forest Invasive Committee meets regularly throughout the year to report pest monitoring activities and research findings and to identify issues and potential funding sources.
- Improved survey methodologies, incorporating new mapping and risk assessment technologies, have been incorporated into annual survey and monitoring activities across the state. A state-of-the-art Digital Mobile Sketchmapping System (DMSM) that incorporates GIS with high-resolution imagery is being used to map over 30 million acres of forest land each year.
- Pest-specific silvicultural guidelines for managing ash and beech in the face of emerald ash borer and beech bark disease infestations have been developed, and FRD field staff has been trained and are incorporating their direction into their management prescriptions.
- The FRD, Forest Health Program has taken the lead in providing training for forest resource professionals, private landowners, homeowners, community leaders and others on forest health issues, hazard tree management and other topics.

### **State Forest Management Plan**

- The 2008 State Forest Management Plan is in its eighth year of implementation, and the state has added three regional forest management plans to the mix that provide more detailed interpretation and specifics to forest management in the three regions of the state forest. The regional plans address and implement forest management on a suite of 101 state forest management areas and address the specifics of cover type management and wildlife habitat specifications. In terms of management of the state forest, this is a major highlight as these plans are the first at this scale within the state. These plans revised the harvest numbers for the state forest and in 2014 an amendment to the State Forest Management Plan was processed and approved to reflect both the changes in harvest numbers and a change in policy related to special conservation areas and most specifically ecological reference areas.

### **Wildlife Action Plan**

- The Wildlife Action Plan is in its tenth year (originally approved in 2005) and is currently being revised. Over the last five years, implementation efforts related to forest management have mainly focused on Kirtland's warbler and jack pine management. The Wildlife Division and the FRD have worked together to ensure timber, rare species and game species management goals are addressed. Through the revision process, the Wildlife Action Plan will develop specific priorities that will better enable linkages between the Forest Action Plan, the regional forest management plans and other plans across the MDNR.

### **State Comprehensive Outdoor Recreation Plan (2013 – 2017)**

- The Michigan State Comprehensive Outdoor Recreation Plan (SCORP) continues to guide recreation priorities in Michigan. Survey results during the development of this SCORP clearly indicated that recreation trails were highly desired by Michigan residents. As a result, trail acquisition and development have been areas of high activity. The Governor's Iron-Belle Trail which extends from southeast Lower Michigan's Belle Isle (in Detroit) to the western Upper Peninsula city of Ironwood has been a top priority. Part of the hiking trail portion of the system (there is also a bike trail on a separate route) is located in Michigan's state forest and along converted rail-road grades. Providing more recreation opportunities

for citizens in the southern portion of the state remains a priority. In support of this priority, the MDNR, working in collaboration with Oakland County, has secured funds for a new off-road vehicle-riding area in southeast Michigan.

### **III. CHALLENGES IN IMPLEMENTATION**

#### **Forest Stewardship**

- There have been several challenges in implementing the Michigan FSP in the first five years of the Forest Action Plan.
- First, there has been some turnover in staff administering the Michigan FSP and gaps between new staff. The first FSP Coordinator retired in late 2010, after about eight years leading the program. After a year with no coordinator, a new Forest Stewardship Program coordinator was hired, but only served the program from 2011-2013. After another year of vacancy, another new coordinator was hired in early 2014 to be the third FSP coordinator in the first five years of the Forest Action Plan implementation. This staff turnover created gaps in service delivery, as new staff took time to be hired and become familiar with the program.
- Secondly, the federal investment in the FSP has decreased significantly during the first five years of the current Forest Action Plan implementation period. The average federal investment in the core FSP has averaged \$266,127 over the past 16 years. The USDA Forest Service funding for the Michigan FSP has fallen to only \$183,000 in FY2014, and \$173,000 in FY2015. The Michigan FSP requires approximately \$250,000 to conduct business as usual and must seek alternate funding sources because the State of Michigan is not replacing lost U.S. Forest Service funds.

#### **Urban and Community Forest**

- Although the first iteration of the Michigan's Forest Resource Assessment and Strategy does provide direction and focus on identifying important issues and priority areas, it was evident from early on that it lacked specificity and detail in both the assessment portion, as well as the related strategies/action steps. This was likely a result of lack of understanding about how the document would ultimately be used or how it could be useful for the UCFP or its partners. Likewise, much of the assessment/analysis was done with dated and low resolution information that limited its usefulness.

#### **Forest Legacy**

- A turnover of experienced staff in the U.S. Forest Service in support of the Forest Legacy Program has resulted in a short-term challenge which will be resolved as new staff gain experience.

#### **Forest/Community Wildfire Protection**

- The Community Wildfire Protection Program will be facing a number of implementation challenges over the next five years, including assuming the responsibilities and duties related to promoting the Firewise Program on a state-wide basis after the services of Michigan State University were lost when their Firewise grant was discontinued. There are also challenges in working with rural residents and private land owners to help them recognize the fire danger possibilities and their role and responsibilities in prevention and implementing Firewise practices around their homes and in their communities. There are additional challenges in the delivery of training needs to local fire organizations and in the development of a state level training academy.

## **Forest Health**

- With nearly 20 million acres of forest lands in Michigan, pest damage can be a challenge to identify in a timely fashion.

## **State Forest Management Planning**

- There are two opportunities for improvement in the implementation of the state and regional forest management plans. First, we need to better define objectives and target for cover type management and better define objectives for other forest values, particularly wildlife habitat. Secondly, we need to improve our conformance monitoring program to track the implementation of the regional plans. This is important in assessing whether or not we are progressing towards or meeting our objectives stated in the plans.

## **Wildlife Action Plan**

- The Wildlife Action Plan is undergoing a major revision to produce a new 10-year plan that will allow for more clear ties with the State Forest Management Plan.

## **Statewide Comprehensive Outdoor Recreation Plan (2013-2017)**

- While the recreation needs of the citizens of the State of Michigan have been identified in the SCORP, adequate funding to meet these needs remains a challenge. The state is extremely fortunate to have the Michigan Natural Resources Trust Fund to provide funding for outdoor recreation, but even that program cannot keep up with the demand for funding for outdoor recreation projects. The federal Land and Water Conservation Fund and the state's Recreation Passport program also provide funding for recreation, but also cannot meet the demand. While significant progress is being made each year to connect and develop trails, provide access to water and all the other recreation uses, funding remains the biggest challenge to fully implementing all items identified in the SCORP.

# **IV. PRIORITIES FOR IMPLEMENTATION OVER NEXT FIVE-YEARS**

## **Forest Stewardship**

- The Michigan FSP has identified priorities for implementing the program in the next five years of the Forest Action Plan implementation period. There are still more than 375,000 family forest landowners in Michigan without a written plan to guide their forest management activities on more than eight million acres of private forest land.
- A few of the priorities for the next five years include:
  - Provide annual training to more than 200 natural resource professionals in the private sector who deliver programs and services to Michigan's 400,000 private forest landowners.
  - Develop new methods for delivering training to natural resource professionals including webinars, websites, videos and other innovative teaching methods.
  - Take advantage of opportunities to increase the number and coverage area of Forest Stewardship Plans each year.
  - Engage, inform, educate and catalyze hundreds of Michigan forest landowners every year to manage, protect and enjoy their forests.
  - Engage municipal forest owners (schools, townships, cities) to encourage community awareness of Forest Stewardship on public and private forest land in Michigan.



- Foster agency and organizational collaboration to deliver well-coordinated private lands assistance to Michigan forest landowners.
- Collaborate with private conservation organizations to develop “Landscape Stewardship Plans” that cover large areas (multiple counties per plan) to find novel ways to deliver the forest stewardship message to thousands of private landowners.
- Engage urban residents, especially in Wayne County, with information about Michigan’s forest resources and opportunities for forest stewardship.

### **Urban and Community Forest**

- Within the next five years, several changes should be made to better present an accurate picture of the UCFP issues, needs and goals. Specifically, the UCFP needs to work with stakeholder groups (e.g., Michigan Urban and Community Forestry advisory council) to review the current plan (and other states’ plans) and make recommendations on needed updates to ensure the document accurately reflects issues and priorities and lays out meaningful and measurable metrics towards achieving desired outcomes. Likewise, it needs to identify and use the most current and highest resolution data for conducting new geospatial assessments that will guide issue modeling and prioritization.

### **Forest Legacy**

- The priorities for Michigan’s Forest Legacy Program over the next five years will focus primarily on building and sustaining a successful program in Michigan. Items of specific focus will include working to build and establish stronger relationships with U.S. Forest Service staff; outreach and education efforts to raise awareness of the Forest Legacy Program; and development of additional competitive and successful projects.

### **Forest/Community Wildfire Protection**

- The focus of the wildfire program in the next five years will be on prevention, training, suppression and suppression planning. Enhancing fire response and preparedness planning is an important priority. Creating new data layers will speed initial attack response and provide valuable information to guide fire managers in decision making. Training will emphasize seeking opportunities for staff to reach wildfire leadership positions which are important to succession planning for wildfire response and management. As part of this training effort, we will concentrate on using our prescribed fire program for on-the-job training opportunities in a controlled setting and partnering with cooperators in training opportunities to be more efficient with our time. Prevention activities will be carried out collaboratively with both the Michigan Interagency Wildland Fire Protection Association and the Great Lakes Forest Fire Compact. Both groups are critical to the development and delivery of a successful wildfire prevention message. The objective of the resource protection wildfire program has been, and continues to be, to safely keep 90% of the wildfire that we respond to, to less than 10 acres. This long standing goal helps us measure the success of our program.

### **Forest Health**

- The FRD’s Forest Health Program will continue to work with partners locally, regionally and nationally to identify resources to ensure forest health issues are detected early and responded to in a timely manner. In particular, the FRD’s Forest Health Program will expand its role as a leader in the development of new tools in the risk management and monitoring. Working closely with U.S. Forest Service Forest Health Technology Team (FHTET) and the U.S. Forest Service’s National Forest Health Monitoring Program, we will work to keep Michigan at the forefront of new technology pilot testing and rollout. In

addition, the Forest Health Program will work to more closely integrate with Forest Operations statewide, including statewide inventory activities, Urban Forestry, Forest Stewardship and forest planning.

### **State Forest Management Planning**

- Priorities related to state forest planning will consist of implementing the regional plans, development of the conformance monitoring component for the three regional state forest plans and taking advantage of any opportunities to address some of the shortcomings that were recognized in the development of the three regional state forest management plans. These shortcomings include incorporation of winter deer ranges, conversion to the new Michigan Forest Inventory system and the development of more specific strategies related to the potential impacts of climate change.

### **Wildlife Action Plan**

- The Wildlife Action Plan is currently under revision, which is expected to be completed by the end of this calendar year. This revision will outline priorities for implementation over the next 10 years.

### **Statewide Comprehensive Outdoor Recreation Plan (2013-2017)**

- Michigan is now known as the trail state and trail acquisition and trail development are top priorities. The Governor's new Iron-Belle Trail, (a hiking and a biking route) running from southeast Michigan (Detroit) to the western end of the Upper Peninsula (Ironwood), is a very large project with many partners in both the public and private sector. Providing more recreation opportunities in southern Michigan especially in urban areas is a high priority, as well as increasing public access to the great lakes shoreline and inland rivers and lakes. These items will be the priority as Michigan implements the remaining years of the current SCORP.

## **V. OPPORTUNITIES FOR IMPROVEMENT IN THE 2020-2030 FOREST ACTION PLAN FOR MICHIGAN**

In looking forward to the development of the next version of the Michigan Forest Action Plan (2020-2030), we see an opportunity to address the following plan components:

### **Vision**

- A new plan will provide an opportunity to better define our vision of where Michigan is going with its forest resources. This will include MDNR's (and most specifically FRD's) story and outline the vision of the future of forests in the state. This is really important in terms of developing plans based on priorities, implementing those plans and assuring both the results and progress towards achieving the vision.

### **Priorities**

- The assessment has produced priority areas for many forest values in Michigan; however, the priorities will be better defined and result in much better identification of 'high priority' areas which will allow for better planning and plan implementation. It will also allow for a means of prioritizing among the various values. A clear vision will greatly improve our ability to identify and address priorities.

## **Goals, Objectives and Targets**

- A new plan (2020-2030) based on a long-term vision will allow us to more effectively identify priority areas and to develop goals, objectives and targets to guide implementation and maximize the benefit of limited funding.

## **Landscape Assessment**

- Michigan has not used a criteria and indicator framework to define the resource assessment. The new plan will allow us to consider use of The Criteria and Indicator Framework for Forest Sustainability in the Northeastern Area to greatly improve the value of the assessment and the establishment of goals, objectives and targets. It would also provide the foundation for reporting.

## **Climate Change**

- The new Forest Action Plan will need to better address the issues related to a potentially changing climate. Although there is a high level of uncertainty around the impacts of climate change, the risks are high and the subject needs to be addressed.

## **Focus**

- The 2010 strategy was largely focused on private lands in southern Michigan despite the assessment of forest resources at the state scale. The focus of the 2020-2030 plan will be adjusted to cover all forest in Michigan and set the stage for developing a broader suite of planning actions related to the broad suite of forest values.

## **Short-Term Revisions**

There are some minor revisions that will be carried out over the next five years to clarify the present document.

The minor revisions would consist of the following items.

- Separation of the current document into two consisting of the resource assessment and the strategy;
- Renaming the two documents to reduce confusion and improve conformity with Northeastern Area Association of State Foresters' direction and terminology;
- Add a piece that tells the MDNR story and includes a vision for the future;
- Edit the document for word changes and clarifications;
- Revise the Table of Contents.

## **Stakeholder Consultation**

The review, minor revisions and plans for the next plan have been discussed with key stakeholder groups including:

- Urban and Community Forestry Advisory Council – March 31, 2015.
- Forest Management Advisory Council – September 9, 2015.
- Stewardship Council-September 18, 2015-meeting canceled, handout provided by e-mail.

Once we are ready to begin the major revision, we will work with these stakeholder groups, including the Department of Defense/Military Installations, in addition to key partners, clients and academics who have knowledge of and interest in future forest resources in Michigan.

## **Data Gaps and Potential Research Areas**

In looking ahead to the next 10-year implementation period, we would like to identify to the U.S. Forest Service, a number of gaps for which new data or research could greatly help the efforts to assess and plan for future forests at the landscape scale and which are essentially beyond the ability of the state to address alone.

- Data Gaps
- More or better quality data in the following areas would be very helpful to the cause:
  - Stand level data for forest conditions across all ownerships, particularly cover type, age-class and stand structure;
  - Wildlife habitat modeling capability to assess habitat supply for a list of featured wildlife across all forest ownerships;
  - Climate change related data in terms of drought associated tree mortality and weather parameters (rainfall, temperature, incidence of late frost, etc.);
  - Soil moisture and productivity mapping;
  - Invasive species mapping;
  - Tree inventory in rural agricultural areas and urban areas (i.e., street tree inventories); and
  - Access to the state level data used in the Forest Sustainability Assessment for the Northern United States report (this is an excellent data and assessment source for all the sustainability criteria).

## **Research Needs**

Similarly, there are some clear research needs that could help with data assessment and ultimately with planning goals and objectives.

- Climate Change: What are the potential effects of changing weather on forest types, particularly those species/cover types that have been identified as potential losers under climate change scenarios? What are the key parameters that we need to be tracking, and what are the thresholds we should be looking for?
- Climate Change: What are the potential cumulative effects of changing weather on forest types, insect pests, diseases and air pollution on the various cover types, particularly those identified as potential losers under climate change?
- Water Quantity and Quality: How much of a watershed should remain in forested condition to maintain water quantity and quality? At what scale of watershed does this apply (i.e., primary, secondary, tertiary, etc.)?
- Forest Composition Metrics: The issues associated with measuring and assessing the meaning of fragmentation needs to be addressed. Similarly, we need to assess other metrics such as patch size (different from fragmentation) and juxtaposition.