Lower Mississippi Valley
JOINT VENTURE

Management Board Meeting

Green-winged Teal © James Childress

October 27, 2021
Video Conference

The Lower Mississippi Valley Joint Venture is a self-directed, non-regulatory private, state, federal conservation partnership that exists for the purpose of sustaining bird populations and their habitats within the Lower Mississippi Valley region through implementing and communicating the goals and objectives of relevant national and international bird conservation plans.

The mission of the LMV Joint Venture is to

function as the forum in which the private, state, federal conservation community develops a shared vision of bird conservation for the Lower Mississippi Valley region; cooperates in its implementation; and collaborates in its refinement.

Table of Contents

LMVJV Management Board Agenda - 27 October 2021

9:00-Noon (CDT)

	ADMINISTRATION	
9:00	Welcome, Introduce New Faces	Raasch
	Spring 2021 Action Items Status	McKnight
	Budget	
	Spring 2022 Venue!	
	Operational Plan Assessment - Year 3	McKnight
	COMMUNICATION	
9:20	Private Landowner Conservation Champion	McKnight
	Request for Nominations & Summer *Leaders on the Land*	
	SCIENCE COORDINATION	
9:25	Marshbird Planning - Working Group Composition	Mini
	Waterfowl Planning	Mini
	Plan Committee Report	
	Quick Updates on Revision Process	
	Manomet Workshop (Stats on on-line, plan for 2022)	Mini
	Louisiana Waterthrush	Mini
	Open Pine Re-Planning	Mini
10:00	**Break**	
	DELIVERY COORDINATION	
10:05	WGCPO Delivery Coordination Summary	Bartush
	RCPP; Texan by Nature; NETX CDN/TLIT Collaboration	
10:15	MAV Delivery Coordination Summary	Brock
	WRE Videos; Forest Markets; DFCW Revision	
	LOOKING AHEAD	
10:45	Big 4 Capacity Needs Primer	McKnight
11:00	**Break**	
11:05	Big 4 Capacity Needs Discussion	All
11:50	Wrap-up, Action Items, Final Thoughts	All
Noon	**Adjourn**	

Administration

LMVJV Management Board Contact List - October 2021					
Name	**Title**	**Organization**	**Email**	**Phone**	**Address**
Jeff Raasch[1] (Chair)	Statewide Wetlands/Joint Venture Program Coordinator	Texas Parks and Wildlife Department	jeff.raasch@tpwd.texas.gov	512.389.4578	Texas Parks and Wildlife 4200 Smith School Road, Austin, TX 78744
Ron Seiss[1] (Vice Chair)	Director, Lower Mississippi River Program	The Nature Conservancy	rseiss@tnc.org	601.713.3307	The Nature Conservancy 217 Rocky Branch Road, Covington, TN 38019
Merrie Morrison	Vice President for Operations	American Bird Conservancy	mmorr@abcbirds.org	540.253.5780	American Bird Conservancy 4249 Loudoun Ave., P.O.Box 249 The Plains, VA 20198
Garrick Dugger	Assistant Wildlife Division Chief	Arkansas Game and Fish Commission	Garrick.Dugger@agfc.ar.gov	501.223.6362	Arkansas Game & Fish Commission #2 Natural Resources Dr., Little Rock, AR 72205
Scott Manley	Director, Conservation Programs (MS, TN, AR, LA, AL)	Ducks Unlimited	smanley@ducks.org	601.956.1936	Ducks Unlimited 193 Business Park Dr., Suite E Ridgeland, MS 39157
Chris Garland	Wildlife Division Director	Kentucky Department of Fish & Wildlife Resources	chris.garland@ky.gov	502.892.4530	Kentucky Department of Fish & Wildlife Resources #1 Sportsman's Lane Frankfort, KY 40601
Kenny Ribbeck[1]	Chief, Wildlife Division	Louisiana Department of Wildlife and Fisheries	kribbeck@wlf.louisiana.gov	225.765.2800	LA Dept Wildlife and Fisheries 2000 Quail Drive P.O. Box 98000, Baton Rouge, LA 70898
Russ Walsh	Executive Wildlife Director	Mississippi Department of Wildlife, Fisheries, & Parks	russw@mdwfp.state.ms.us	601.432.2202	Mississippi Dept of Wildlife, Fisheries, & Parks 1505 Eastover Drive, Jackson, MS 39211-6374
Joel Porath	Wildlife Management Chief-Ozark Unit	Missouri Department of Conservation	joel.porath@mdc.mo.gov	573.522.4115 ext 3188	Missouri Dept. of Conservation P.O. Box 180, Jefferson City, MO 65102
Jeremy Everitts	District Biologist (AR, LA, MS)	National Wildl Turkey Federation	jeveritts@nwtf.net	301.667.1072	43 J Hawks Drive Greenbrier, AR 72058
Jeff Ford	Senior Biologist	Oklahoma Department of Wildlife Conservation	jeff.ford@odwc.ok.gov	918.527.9918	Oklahoma Dept. of Wildlife Conservation 49077 Fish Hatchery Rd. Hodgen, OK 74939
Patrick Lemons	Wildlife Program Manager, Region 1	Tennessee Wildlife Resources Agency	patrick.lemons@tn.gov	731.697.5200	200 Lowell Thomas Drive Jackson, TN 38301
Kristin Madden[1]	Deputy Chief, Migratory Birds	US Fish and Wildlife Service (Albuquerque)	kristin_madden@fws.gov	505.248.6878	U.S. Fish & Wildlife Service 500 Gold Avenue SW, Albuquerque, NM 87102
Mike Oetker	Deputy Regional Director	US Fish and Wildlife Service (Atlanta)	michael_oetker@fws.gov	404.679.4000	U.S. Fish & Wildlife Service 1875 Century Blvd., Atlanta, GA 30345
Mike Langston	Deputy Director, SC Climate Science Adaptation Center	US Geological Survey	mlangston@usgs.gov	405.290.8348	U.S. Geological Survey, South Central CASC 5 Partners Place University of Oklahoma
Eddie Taylor	Forest Supervisor, Kisatchie NF	USDA Forest Service, Region 8	etaylor@fs.fed.us	318.473.7160	U.S.D.A. Forest Service 2500 Shreveport Highway, Pineville, Louisiana 71360-2009
Mike Sullivan	State Conservationist, Arkansas	USDA Natural Resource Conservation Service	michael.sullivan@ar.usda.gov	501.301.3100	U.S.D.A. NRCS Room 3416, Federal Building 700 W. Capitol Ave, Little Rock, AR 72201-3215

[1]Executive Committee

LMVJV Management Board – 2 June 2021

Webinar

Decisions & Action Items
Status in Green

Administration

- **Future Board Meeting Locations**
  - 2021 Fall: Ducks Unlimited National Headquarters, Memphis, TN; 26-27 October 2021
  - 2022 Spring: Arkansas; details TBD

  Responsible: Primary, K. McKnight; All Applicable Board Members
  Ongoing Struggle with COVID-19 Travel Issues

- **"Big 4" Horizon Issues**
  - Executive Committee to work with Coordinator & Office Staff in preparing information and materials for Fall discussion regarding prioritization and strategies to meet major science and delivery challenges.
  - Board members encouraged to pass along questions, thoughts, suggestions regarding what they/we need to better inform decisions on investment at the October 2021 meeting

  Responsible: Primary, K. McKnight & Executive Committee; All Board Members and Office Staff
  Discussion slated for Fall 2021 Board Video Meeting

Science

- **Monitoring & Evaluation Plan**
  - Board Approved. Motion, J. Porath; Second, K. Ribbeck. Unanimous approval.
- **Monitoring & Evaluation Plan**
  - Science Team and partners encouraged to identify clear connections between M&E priorities and potential Restoring America's Wildlife Act (RAWA) opportunities

  Responsible: Primary, Science Coordinator; Science Team
  Ongoing

Communication

- **Private Landowner Conservation Champion – Information Dissemination**
  - Provide short paragraph summary for each of the 2020 PLCCs, along with recent photos for partner agencies' use in press releases.

  Responsible: Primary, G. Elliott & K. McKnight
  Complete (News piece in wlf.louisiana.gov; knoe.com/2020/10/07/lincoln-parish-couple-wins-conservation-award/

June 2, 2021 Management Board Call/Meeting Participants

Board Member	Organization
Tom Doyle	US Geological Survey
Garrick Dugger	Arkansas Game & Fish Commission
Chris Garland	Kentucky Department of Fish & Wildlife Resources
Houston Havens (for Walsh)	Mississippi Dept. of Wildlife, Fisheries, and Parks
Patrick Lemons	Tennessee Wildlife Resources Agency
Kristin Madden	US Fish and Wildlife Service, Southwest
Scott Manely	Ducks Unlimited
Merrie Morrison	American Bird Conservancy
Mike Oetker	US Fish and Wildlife Service, Southeast
Joel Porath	Missouri Department of Conservation
Jeff Raasch	Texas Parks and Wildlife Department
Kenny Ribbeck	Louisiana Department of Wildlife and Fisheries
Ron Seiss	The Nature Conservancy
Mike Sullivan	Natural Resources Conservation Service
Partners/Guests	**Organization**
Janine Antalffy	USFWS Directorate Fellow
David Briethaupt	Louisiana Department of Wildlife and Fisheries
Jeff Denman	Private Consultant
Ryan Diener	Pheasants Forever/Quail Forever
Gregg Elliott	KGregg Consulting
Annie Farrell	National Wild Turkey Federation
Justyn Foth	USFWS-HQ
David Graves	Arkansas Game & Fish Commission
Dale James	Ducks Unlimited
Chad Kacir	Natural Resources Conservation Service - LA
Jason Keenan	Natural Resources Conservation Service - MS
Austin Klaais	Pheasants Forever/Quail Forever
Tim Landreneau	Natural Resources Conservation Service - LA
Amanda Mathis	Natural Resources Conservation Service - AR
Jeremy Poirier	International Paper
Jenny Sanders	Texas Longleaf Implementation Team
Stacey Shankle	Trust for Public Land
EJ Williams	American Bird Conservancy
LMVJV Office Staff	
Bill Bartush	WGCPO Partnership Coordinator
Steve Brock	MAV Partnership Coordinator
Blaine Elliott	GIS Applications Biologist
Keith McKnight	Coordinator
Anne Mini	Science Coordinator

LMVJV Management Board Agenda - 2 June 2021

	ADMINISTRATION	
NOON	Welcome, Introduce New Faces	McKnight
	Fall 2020 Action Items Status	
	Budget Outlook	
	Fall Venue	
	DELIVERY COORDINATION	
12:30	**Mississippi Alluvial Valley**	
	AR MAV CDN Report	David Graves
	LA-MS CDN Report	David Breithaupt
	TCP (including WREP Update)	Brock/Seiss
1:00	**West Gulf Coastal Plain/Ouachitas**	
	Longleaf Pine Partnerships Overview	Bartush
	Texas LIT - Priority Geography & Outlook	Jenny Sanders
	NETX CDN Report	Annie Farrell
	AR-LA CDN	Bartush
	MFFI Update	Austin Klais
	AR-LA RCPP Update	Amanda Mathis
1:45	BREAK	
2:00	DFCW Revision	Jeff Denman
	International Paper & BHW Priorities	Jeremy Poirier & EJ Williams
	SCIENCE COORDINATION	
2:30	Palustrine Wetland Assessment Progress/Report	Mike Mitchell
	DFP Student (LOWA HIS Model Devel.) Update	McKnight
	Monitoring & Evaluation Plan Approval* **	Mini
	2022 Waterfowl Objectives/Plan Update	Mini
	Science Support Spending Update	McKnight/Mini
	COMMUNICATION	
3:00	Private Landowner Newsletter Progress	Gregg Elliott
	BROADER PARTNERSHIP	
3:20	SECAS Blueprint/JV Comparison Study Update	McKnight
	LOOKING AHEAD	
3:30	Big Horizon Issues Bird, Social, Hydrological, and Climate Science and *America the Beautiful*	McKnight
4:00	Wrap-up, Action Items, Final Thoughts	
4:15	Adjourn	

*****Decision item for the Management Board**

LMVJV Management Board Contact List - May 2021

Name	Title	Organization	Email	Phone	Address
Jeff Raasch[1] (Chair)	Statewide Wetlands/Joint Venture Program Coordinator	Texas Parks and Wildlife Department	jeff.raasch@tpwd.texas.gov	512.389.4578	Texas Parks and Wildlife 4200 Smith School Road, Austin, TX 78744
Ron Seiss[1] (Vice Chair)	Director, Lower Mississippi River Program	The Nature Conservancy	rseiss@tnc.org	601.713.3307	The Nature Conservancy 217 Rocky Branch Road, Covington, TN 38019
Merrie Morrison	Vice President for Operations	American Bird Conservancy	mmorr@abcbirds.org	540.253.5780	American Bird Conservancy 4249 Loudoun Ave., P.O.Box 249 The Plains, VA 20198
Garrick Dugger	Assistant Wildlife Division Chief	Arkansas Game and Fish Commission	Garrick.Dugger@agfc.ar.gov	501.223.6362	Arkansas Game & Fish Commission #2 Natural Resources Dr., Little Rock, AR 72205
Scott Manley	Director, Conservation Programs (MS, TN, AR, LA, AL)	Ducks Unlimited	smanley@ducks.org	601.956.1936	Ducks Unlimited 193 Business Park Dr., Suite E Ridgeland, MS 39157
Chris Garland	Wildlife Division Director	Kentucky Department of Fish & Wildlife Resources	chris.garland@ky.gov	502.892.4530	Kentucky Department of Fish & Wildlife Resources #1 Sportsman's Lane Frankfort, KY 40601
Kenny Ribbeck[1]	Chief, Wildlife Division	Louisiana Department of Wildlife and Fisheries	kribbeck@wlf.louisiana.gov	225.765.2800	LA Dept Wildlife and Fisheries 2000 Quail Drive P.O. Box 98000, Baton Rouge, LA 70898
Russ Walsh	Executive Wildlife Director	Mississippi Department of Wildlife, Fisheries, & Parks	russw@mdwfp.state.ms.us	601.432.2202	Mississippi Dept of Wildlife, Fisheries, & Parks 1505 Eastover Drive, Jackson, MS 39211-6374
Joel Porath	Wildlife Management Chief-Ozark Unit	Missouri Department of Conservation	joel.porath@mdc.mo.gov	573.522.4115 ext 3188	Missouri Dept. of Conservation P.O. Box 180, Jefferson City, MO 65102
Jeremy Everitts	District Biologist (AR, LA, MS)	National Wildl Turkey Federation	jeveritts@nwtf.net	301.667.1072	43 J Hawks Drive Greenbrier, AR 72058
Jeff Ford	Senior Biologist	Oklahoma Department of Wildlife Conservation	jeff.ford@odwc.ok.gov	918.527.9918	Oklahoma Dept. of Wildlife Conservation 49077 Fish Hatchery Rd. Hodgen, OK 74939
Patrick Lemons	Wildlife Program Manager, Region 1	Tennessee Wildlife Resources Agency	patrick.lemons@tn.gov	731.697.5200	200 Lowell Thomas Drive Jackson, TN 38301
Kristin Madden[1]	Deputy Chief, Migratory Birds	US Fish and Wildlife Service (Albuquerque)	kristin_madden@fws.gov	505.248.6878	U.S. Fish & Wildlife Service 500 Gold Avenue SW, Albuquerque, NM 87102
Mike Oetker	Deputy Regional Director	US Fish and Wildlife Service (Atlanta)	michael_oetker@fws.gov	404.679.4000	U.S. Fish & Wildlife Service 1875 Century Blvd., Atlanta, GA 30345
Tom Doyle	Deputy Director, National Wetlands Research Center	US Geological Survey	doylet@usgs.gov	337.266.8647	U.S. Geological Survey, Wetland & Aquatic Research Center 700 Cajundome Blvd., Lafayette, LA 70506
Eddie Taylor	Forest Supervisor, Kisatchie NF	USDA Forest Service, Region 8	etaylor@fs.fed.us	318.473.7160	U.S.D.A. Forest Service 2500 Shreveport Highway, Pineville, Louisiana 71360-2009
Mike Sullivan	State Conservationist, Arkansas	USDA Natural Resource Conservation Service	michael.sullivan@ar.usda.gov	501.301.3100	U.S.D.A. NRCS Room 3416, Federal Building 700 W. Capitol Ave, Little Rock, AR 72201-3215

[1] Executive Committee

LMVJV FY2021 Budget

Income/Expense Summary	
Income	
FY21 Mig Bird Joint Venture (1234)[1]	$842,461
MS Mig Bird Field Office (Admin Support)	
Mig Bird Funds for SE 3BB Analysis	$13,000
Partner Contribution & Agreement Funds	
To Agreements	
ABC	$89,167
To Office Expense	
Income Total	**$944,628**
Expenses	
Salary & Benefits (USFWS)[1]	$575,152
Travel	$1,554
Operational	$10,726
Regional Office Support (@4.3%)	$36,199
Office Space	$30,000
ABC Agreement - 3BB SE Analysis	$13,000
ABC Agreement - Science Coord.	$156,167
ABC Agreement - WGCPO PC	$110,000
Communications Contract	$10,000
Science Project Support	$0
Expense Total	**$942,797**
Balance	**$1,831**

[1] includes the following 4 USFWS staff:
Coordinator (McKnight)
Partnership Coordinator (Brock)
GIS Applications Biologist (Elliott)
Office Administrator (McHan)

Partner Contributed Funds Summary		
Carryover from FY2020		**$69,247**
FY21 Contributions		
LDWF		**$33,333**
AGFC		
TPWD		**$25,000**
NRCS		**$87,805**
ODWC		**$5,000**
TWRA ($11,250)*		
MDC ($8,000)*		
DU (in kind support)	$16,800	
FY21 Subtotal		$151,138
Total Avaliable		**$220,385**
Withdrawal: Agreement/Project		-$89,167
Withdrawal: USFWS Staff/Expense		$0
Balance		**$131,218**

*TWRA ($11,250) & MDC ($8,000) go directly to ABC; accounted as reduction in total Science Coordinator expense

Agreement / Activity	From PC	From 1234	From 1231	TOTAL
DU - Partnership & Science Support				
ABC - Partnership Coordination	$30,000	$80,000		$110,000
ABC - Science Coordination	$49,167	$107,000		$156,167
ABC - 3BB Analysis			$13,000	$13,000
ABC - Communications Contract	$10,000			$10,000

Lower Mississippi Valley Joint Venture
Management Board Meeting Locations 2002-2021

Fa/Wi 2022	TBD
Sp/Su 2022	Memphis, TN; DU Headquarters
Fa/Wi 2021	Video conference (in-person meeting not possible due to COVID-19 issues)
Sp/Su 2021	Video conference (in-person meeting not possible due to COVID-19 issues)
Sp/Su 2020	Video conference (in-person meeting not possible due to COVID-19 issues)
Fa/Wi 2020	Video conference (in-person meeting not possible due to COVID-19 issues)
Sp/Su 2019	**Texas (Jefferson)**
Fa/Wi 2019	**Louisiana (Cypress Bend)**
Sp/Su 2018	**Louisiana (West Monroe)**
Fa/Wi 2018	**Mississippi (Natchez)**
Sp/Su 2017	**Missouri (Cape Girardeau)**
Fa/Wi 2017	**Tennessee (Dyersburg)**
Sp/Su 2016	**Arkansas (Wildlife Farms)**
Fa/Wi 2016	**Louisiana (Baton Rouge, after SEAFWA; October 19-20 *OR* 20-21)**
Sp/Su 2015	**Mississippi (Tara Wildlife)**
Fa/Wi 2015	**Tennessee (Millington)**
Sp/Su 2014	**Texas (Caddo Lake State Park)**
Fa/Wi 2014	Florida (SEAFWA)
Sp/Su 2013	**Louisiana (Lafayette)**
Fa/Wi 2013	Oklahoma (SEAFWA)
Sp/Su 2012	**Arkansas (Heber Springs)**
Fa/Wi 2011	Tennessee (SEAFWA)
Sp/Su 2011	**Arkansas (Eureka Springs)**
Fa/ Wi 2010	Mississippi (SEAFWA)
Sp/Su 2010	**Arkansas (5 Oaks Lodge)**
Fa/Wi 2009	Georgia (SEAFWA)
Sp/Su 2009	**Oklahoma (Broken Bow)**
Sp/Su 2008	**Mississippi (Vicksburg)**
Sp/Su 2007	**Texas (Tyler)**
Sp/Su 2006	**Mississippi (Vicksburg)**
Sp/Su 2005	**Arkansas (Winrock)**
Sp/Su 2004	**Louisiana (Buras)**
Fa/Wi 2003	Alabama (SEAFWA)
Sp/Su 2003	**Texas (Big Woods on the Trinity)**
Sp/Su 2002	**Mississippi (Tara Wildlife)**

2-Day Location	**"Box Score"**
Arkansas	5
Louisiana	5
Mississippi	5
Texas	4
Tennessee	2
Missouri	1
Oklahoma	1

Bold = Multi-day meeting
Gray = Planned

Lower Mississippi Valley Joint Venture

Progress Assessment of
2018 Operational Plan Goals & Priorities

Year 3

Lower Mississippi Valley
JOINT VENTURE
www.lmvjv.org

October 2021

LMVJV Operational Plan – Year 3 Progress

The Lower Mississippi Valley Joint Venture (LMVJV) was formed in 1987 as a regional partnership working towards achieving the goals and objectives of the North American Waterfowl Management Plan (NAWMP), and now assumes responsibility for planning, designing, coordinating, and implementing conservation in support of the U.S. Shorebird Conservation Plan, North American Waterbird Conservation Plan, and Partners in Flight Landbird Conservation Plans as well. The conservation landscape has changed (for better and worse) since the inception of the LMVJV and many challenges remain to be addressed. To facilitate a focused and efficient pursuit of shared partnership objectives, the LMVJV is guided by a 5-year Operational Plan.

The 2018 Operational Plan articulates the collective expectations of the Management Board with respect to how the LMVJV operates, interacts, and cooperates among all its parts (office staff, partners, other partnerships), and the essential expected outcomes. The primary purpose of the Plan is to ensure that the LMVJV Management Board, coordinator, office staff, and partner staff have proper context for making key (and perhaps tough) resource allocation decisions.

This document summarizes an assessment of progress after three years of work under the 2018 five-year plan.

Organizational Performance

Priority A

Consistent, high-level engagement and involvement from Management Board members

Change from 2020: None

Positives

Solid interest and participation in JV activities by all Management Board members continues. Management Board members actively facilitate increased involvement by their organization's staff in LMVJV technical teams, etc. All Board seats currently filled.

Challenges

Turnover in Management Board members challenges us to share institutional knowledge, maintain a common context, and ensure continuity through time.

Priority B

Consistent, high-level engagement and involvement from partner staff in technical and delivery teams

Change from 2020: None

Positives

Partner staff participation in all CDNs (40-60 active members each) continues to be very high, even with COVID-altered venues and approaches. Field Days (in lieu of traditional indoor gatherings) have been well received and effective.

Participation and input provided by science-related working groups is generally high (e.g., WGCPO BHW HSI development, MAV Forest Protection Model, MAV Forest Breeding Bird Plan revision, NETX Bird Monitoring, RCPP Science elements).

Challenges

COVID-19 restrictions have dictated a combination of video, phone, and field gathering.

Priority C

Effective communication of LMVJV activities

Change from 2020: None

Regular email updates on timely issues sent to Board members and partner networks, with four *News & Updates* e-newsletters distributed in the past year.

New website launched in 2019, with frequent updates, including videos of virtual meetings allowing for more innovative application of video meeting platforms in 2020 and 2021.

Glossy summaries of five LMVJV Plans (MAV Waterfowl, Shorebird, WGCPO Open Pine, WGCPO Forest Wetland, MAV Forest Breeding Bird) completed and posted on the website.

Several partner accomplishments (e.g., acquisition, restoration) have been communicated to the partnership via *News & Updates*, owing to the provision of this information by partner organizations to JV staff.

Numerous informational emails (CDN Blasts) forwarded to all CDN participants related to an array of topics including relevant news articles, bulletins, position announcements, webinars and workshops.

Leaders on the Land private landowner newsletter launched Summer 2021, second edition distributed in October 2021.

Organizational Performance (cont'd)

Priority D

Cultivating relationships with key DOI & USFWS decision-makers and relaying accomplishments

Change from 2020: None

Positives

LMVJV Board Chair coordinated "fly-ins" among USFWS Southwest (2018) & Southeast (2020) Region JVs and USFWS Regional leadership. The efforts were successful and well received.

LMVJV Coordinator and Chair participated in DC fly-in meetings with USFWS Leadership (Director, Deputy Director, Program Leadership) in February 2020.

LMVJV report to NAWMP Plan Committee, including USFWS Assist. Director for Migratory Birds, September 2021.

Challenges

Maintaining regular contact with key staff for building relationships is an ongoing challenge, especially with restricted travel and in-person meetings.

Inclusion of Conservation without conflict and NAFO coordination with Southwest/Southeast Regions for seamless conservation planning of At Risk Species in our shared landscapes.

Priority E

Cultivating new sources of funding for partner activities

Change from 2020: Improved

Positives

Regional Conservation Partnership Program (RCPP) awarded in 2021 for Open Pine conservation in the WGCP of Arkansas and Louisiana ($5.9MM RCPP, $8.1MM partners). Includes Innovative contribution opportunity from energy ROW managers.

Wetlands Reserve Enhancement Program (WREP) awarded in 2021 for wetland conservation in the MAV ($46MM).

USFWS Migratory Bird funds secured for MAV emergent wetland remote assessment ($26K) supporting planning for secretive marshbirds and other taxa; a 2021 Shorebird/Waterbird Workshop ($10K); and an assessment of SE JV and SECAS Blueprint outputs ($80K) and recommendations for better harmonization.

NFWF 2020 LMAV Fund approved $2.6MM to partners in 8 projects. JV Staff directly involved in successful proposals for DFCW Revision, MAV Bird Monitoring, and Tri-State WREP (AR, LA, MS).

Texas Longleaf Team's Texan by Nature "Wrangler" award is promoting collaboration with industry partners in East Texas.

Expanded TPWD funding for Delivery programs with landscape priority focus (increased two-fold from $100 to $166-$200k annually for 2-4 years).

Challenges

Accessing funds from sources outside of our traditional streams is an ongoing and worthwhile process that requires time, energy, and coordination.

Identifying and cultivating additional new donors to LMVJV partner efforts, while avoiding conflict with ongoing development efforts by partner organizations is a delicate process.

Organizational Performance (cont'd)

Priority F

Sufficient JV Office budget to support staff, travel, and activities

Change from 2020: None

<u>Positives</u>

Migratory Bird Joint Venture (1234) funding levels remain relatively flat to increasing ($1.5MM increase in FY20), despite reductions in other programs.

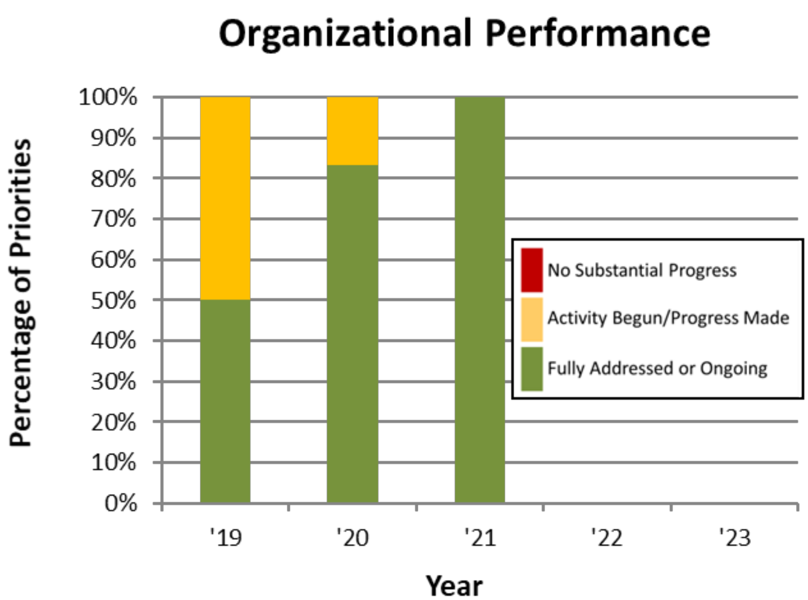
LDWF, AGFC, MDC, TWRA, NRCS, ODWC, and TPWD are contributing funds to the LMVJV Support Office to augment 1234 funds.

TPWD provides office space and support to JV staff in TX.

NFWF funds, through an amended award to ABC, provide approx. 50% of the WGCPO Partnership Coordinator's costs through 2024.

<u>Challenges</u>

Securing additional outside (e.g., NFWF) funding requires ongoing investment.



Year 3 ('21) Priorities Status

- Board member engagement
- Partner staff engagement
- Communication of JV activities
- Communication with DOI & USFWS
- Cultivate and increase funding sources†
- Sufficient Office budget to support staff

†Change since 2020

Biological Planning

Goal 1: Landscape-oriented, biologically driven, partner vetted, up-to-date population objectives for priority species within all bird guilds in both BCRs by 2023

Highest Priority

Waterbirds of the Mississippi Alluvial Valley & West Gulf Coastal Plain/Ouachitas Plan

Change from 2020: None

Positives

Waterbird Working Group assembled, first meeting held 22 September 2021.

Univ. of Arkansas Monticello marshbird research underway, with funding from LMVJV.

DU, in collaboration with JV staff, conducting emergent wetland assessment, fundamental to assessing marshbird habitat.

Challenges

This effort is challenged by a lack of population data to set defensible population objectives. Habitat and habitat use data collection ongoing.

Highest Priority

MAV Landbird Plan Revision

Change from 2020: None

Positives

Drs. Twedt & Mini published an update to the landbird biological model for the MAV as USGS Open File Report. Board approved new Population & Habitat Objectives September 2020.

Challenges

Peer reviewed document synthesizing all four components of planning & design envisioned, not yet begun.

Highest Priority

WGCPO Open Pine Plan Revision

Change from 2020: None

Discussions with partners through CDN activities ongoing. Scientists at Mississippi State University, through separate but related contract, are developing key base information/data layers and approaches to be used in the revision. Revision to be completed in 2022.

Biological Planning (cont'd)

High

Waterfowl – New Population Objectives

Change from 2020: **None**

Positives

New population objectives have been completed by LMVJV Science Coordinator and shared with Waterfowl Working Group leadership. With the GCJV, we have agreed upon an interpretation of the dual NAWMP objectives (80^{th} percentile vs. Long-term average).

Improved Water Management Tool deployed, with new data from partners to serve foundational role in revised plan.

Revised population and habitat objectives to be accomplished in 2022.

Challenges

Including human dimensions objectives in revised planning is new ground for LMVJV.

Medium

Multi-JV grassland bird conservation planning ("Murmuration")

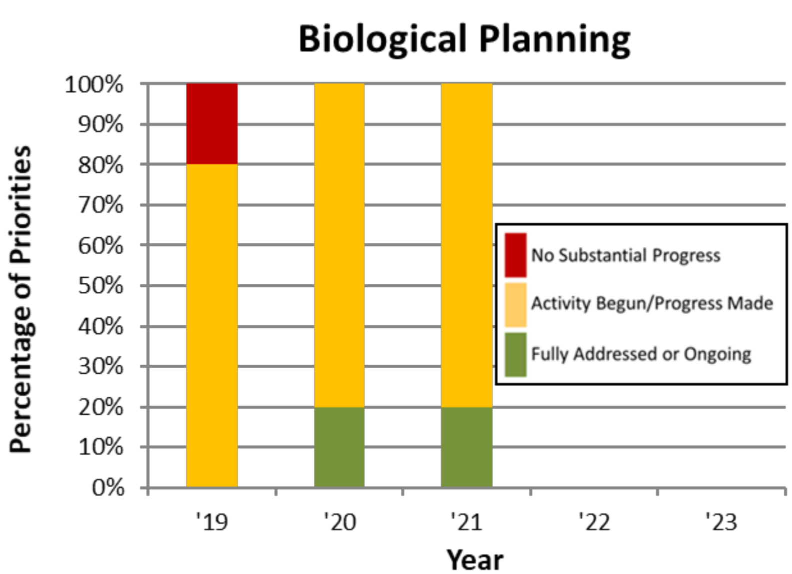
Change from 2020: **None**

Positives

Science Coordinator participating in periodic planning discussions re: scope, approach, and study sites.

Challenges

Funding to conduct field work necessary to develop Full Annual Cycle models has not been fully obtained.



Year 3 ('21) Priorities Status

- Waterbird Planning
- MAV Landbird Plan Revision
- WGCPO Open Pine Plan Revision
- Waterfowl Objectives Updated
- Grassland Bird Murmuration

Conservation Design

Goal 2a: Up-to-date habitat objectives for priority species within each bird guild in both BCRs by 2023

Goal 2b: Effective decision support tools to link and integrate habitat objectives for priority species in each bird guild and other relevant resource concerns, useful for delivery action by 2023

Highest Priority Waterbirds of the Mississippi Alluvial Valley & West Gulf Coastal Plain/Ouachitas Plan **Change from 2020: None**	Positives Palustrine emergent wetland remote assessment tool is well on the way to completion (winter 2021). Waterbird Working Group has met, with resultant timeline, tasks assigned, and next-steps established. Challenges Next steps are completion of the assessment, then application of these data to as-yet undeveloped Marshbird models.
Highest Priority WGCPO Open Pine Plan Revision **Change from 2020: None**	Engagement of new membership/leaders within the AR-LA CDN, Delivery & Prioritization Team was extensive in 2020-21. Scientists at Mississippi State University, through separate but related contract, are developing key base information/data layers and approaches to be used in the revision. Continued dialogue with USFWS Science Applications staff regarding Integration of SWAP efforts in AR & LA with CDNs should prove fruitful. Revision to be completed in 2022.Collaboration with Longleaf and Open Pine partnerships (NETX & TLIT) has advanced the dialogue of seamless delivery across western WGCPO – BCR 25
Highest Priority CDN Delivery Priorities updated and distributed **Change from 2020: None**	LMVJV staff provided GIS and related expertise in development of the latest Texas Longleaf Implementation Team priority geography map. The AR-LA CDN, galvanized around the RCPP effort, has solidified a shared partner vision of high priority landscapes and practices.
High Waterfowl – New Population Objectives translated to habitat objectives **Change from 2020: None**	Positives The LMVJV Waterfowl Working Group 'executive committee' is poised to lead revision of waterfowl population and habitat objectives in 2022, based in part on the newly improved WMU Tool.

Conservation Design (cont'd)

High

Human Objectives developed for waterfowl

Change from 2020: None

Positives

Early discussions with developers of the NAWMP Regional Conservation Planning Tool (includes social inputs) allowing for LMVJV to "test-drive" for our use.

Challenges

Need access to and expertise in application of the tool.

High

Integration of priorities among guilds, ecosystem services, etc.

Change from 2020: None

Positives

Should have solid planning/design (spatially-explicit) products for <1 bird guilds in both BCRs by the end of the 5-year Op Plan horizon.

Challenges

Developing and updating basic biological plan/design elements is staff-intensive and occupies a higher priority than does integration.

Medium

Multi-JV grassland bird conservation planning ("Murmuration")

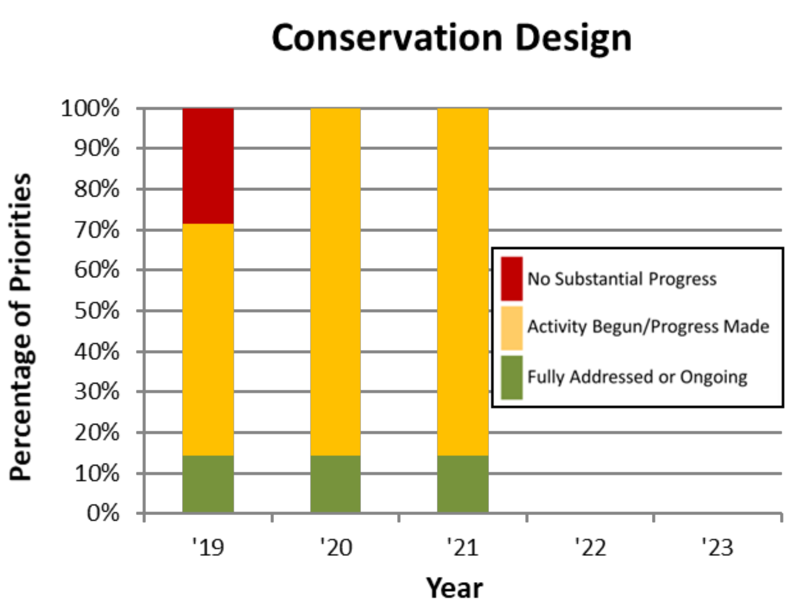
Change from 2020: None

Positives

Some progress made in implementing portions of the effort.

Challenges

Funding to conduct field work necessary to develop Full Annual Cycle models has not been obtained.



Year 3 ('21) Priorities Status

- Waterbird Priorities
- WGCPO Open Pine Priorities Revision
- CDN Priorities
- Waterfowl Objectives Updated
- Waterfowl Human Objectives
- Integration Among Guilds
- Grassland Bird Murmuration

Habitat Delivery

Goal 3a: The Partnership actively seeks and fosters existing and emerging opportunities for coordinated habitat delivery in support of LMVJV objectives

Goal 3b: Establish fully-functioning Conservation Delivery Networks throughout the JV, guided by LMVJV objectives by 2023

Goal 3c: Fully supported long-term functionality and productivity of existing Conservation Delivery Networks and Tri-state Conservation Partnership

Highest Priority

Continue support of existing CDNs & Cooperatives:

- CDNs
- Tri-state Cons. Partnership
- Longleaf Partnerships

Change from 2020: None

Positives

Much LMVJV Office staff and partner staff time continues to be invested in support of existing cooperatives and networks.

Conservation Delivery Networks. all four CDNs continue to function well and benefit from active support of the LMVJV staff. CDN membership participation remains high, with 30-50 attendees typical at regular CDN meetings, workshops and field days, with similar participation in virtual meetings which have often been required due to COVID-19 restrictions. As intended, these CDNs have developed and updated their priorities to address coordination and information needs unique to their geographies. For example, the AR and LA/MS MAV CDNs maintain active Working Ag Lands Working Groups, and are working to address opportunities for CDN partners to more effectively implement conservation actions in the MAV working agriculture landscape. In 2021, the MAV CDNs have placed specific focus on Desired Forest Conditions for Wildlife (DFCW) and in the midst of the pandemic, have hosted both virtual and in-person DFCW-focused meetings led by technical experts from within the JV partnership. The AR MAV CDN was also able to hold a DFCW-focused field trip as part of its summer meeting.

The NE TX CDN has developed a successful private lands program (NETX Habitat Incentive Program [HIP]), improving over 15,000 acres of private lands in five years.

The AR-LA WGCP CDN has effectively applied both JV Office and Partner Staff leadership towards significant success in 2021, with the awarding of a $5.9MM RCPP.

Longleaf Partnerships. JV Office staff continue to provide technical guidance, communication and logistical support to the TX Longleaf Implementation Team (TLIT). JV Office staff continue to work with the Western Louisiana Ecosystem Partnership (WLEP). A Tall Timbers Pineywoods Quail Program Biologist will soon base out of Livingston, TX. Continued connections to LLA, America's Longleaf, Tall Timbers, and LA - TX partners will ensure optimal communication and shared resources.

Tri-state Conservation Partnership (TCP). The TCP continues to experience strong support and engagement from NRCS and other JV partners. In addition, the TCP maintains its important and productive working relationship with the MAV CDNs, as much of the work of the TCP is directly fostered through and supported by the MAV CDNs, their participants and working groups (additional details below).

Challenges

Effective communication and coordination of these multiple partnerships requires special attention as the activities and opportunities increase in number and frequency, and as partner staff composition and participation changes over time.

High

Develop and foster unique partnership opportunities at sub-regional scale

- Tri-state Conservation Partnership

Change from 2020: None

The **Tri-state Conservation Partnership** (TCP) was initiated in 2013 and was fully formalized through the JV in 2015 with a Declaration of Partnership (signatories: NRCS AR, LA, MS & LVMJV). This unique partnership continues to be successful and strong, serving as an effective mechanism for fostering engagement among LMVJV partners in support of shared delivery priorities within the MAV of AR, LA & MS. Many of the Farm Bill centered delivery priorities identified by TCP planning are shared and promoted through the CDN's and are often effectively accomplished through CDN based working groups. In tandem with CDNs, the TCP has become an important catalyst for supporting and addressing JV delivery interests. JV Staff continue to work directly with Board member Seiss (TNC's Lower MS River Prog. Coordinator) in leading the stewardship of the TCP. Specific recent examples of the productive collaboration resulting from the TCP/CDN relationship include:

- A TCP/CDN based, Wetland Reserve Easement (WRE) Outreach Working Group is finalizing and preparing to release seven landowner videos focused on wetland and forest management on WRE properties. The project was funded through a MS NRCS grant and is designed to educate landowners with easements in the MAV of AR, LA and MS, on WRE management guidelines and effective habitat management. The complete video series is targeted for release by late-Oct/early-Nov 2021.

- The TCP was awarded funding for a third phase of its multi-year MAV Tri-state WREP project. The NRCS fully funded the proposed $20M project, which will restore ~6,000 wetland acres of MAV marginal cropland. The project included an additional $1M in partner match, a significant portion of which came from a successful NFWF grant award sourced by the Walton Family Foundation, an Arbor Day Foundation grant, as well as in-kind support from Ducks Unlimited and Wildlife Mississippi.

Challenges

With ever increasing needs and demands across multiple JV priorities, the continued growth and success of the TCP does serve to intensify overall demands on JV staff capacity. No other TCP-like partnerships are in development.

Medium

Be responsive to partners' desire to develop additional CDNs

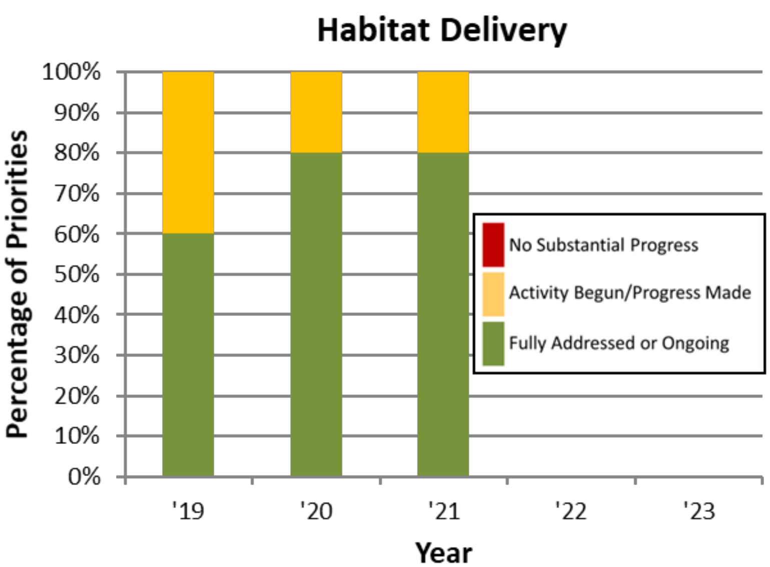
Change from 2020: None

Positives

Some level of interest has been previously expressed for establishing CDNs in both the Atchafalaya Basin and the MAV of MO/KY/TN. To date, no concrete interest has been demonstrated by key JV partners to initiate CDN establishment in these areas.

Challenges

In order for new CDN's to be formulated and successfully established, strong support and commitment from a lead JV partner organization within a given area is required. Oklahoma dialogue has been initiated with NWTF, USFS and State personnel, however with limitations on travel and meetings, this engagement has not progressed beyond the formative stages



Year 3 ('21) Priorities Status

- Support to CDNs
- Support to Tri-state Conserv. Partnership
- Support to Longleaf Partnerships
- Develop & Foster Unique Opportunities
- Responsive to Additional CDNs

Monitoring & Evaluation

Goal 4a: Develop iterative habitat and population monitoring & evaluation priorities by 2020

Goal 4b: Capitalize on opportunities for effects monitoring that support LMVJV priority habitat conservation actions

Highest Priority

Monitoring & Evaluation Plan

Change from 2020: **Improved**

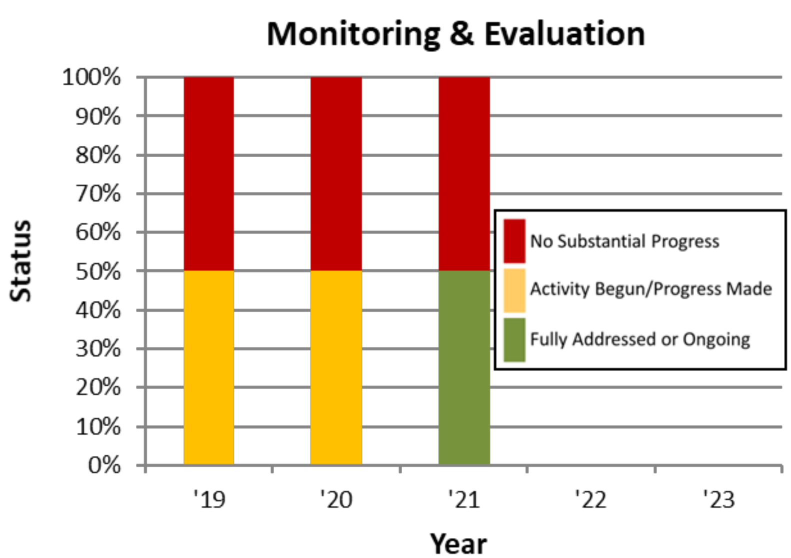
Monitoring and Evaluation Plan was approved by the Management Board Fall 2020.

High

Pilot public use evaluation

Change from 2020: **None**

No progress.



Year 3 ('21) Priorities Status

Monitoring & Evaluation Plan†

Pilot Public Use Evaluation

†Change since 2020

Research

Goal 5a: Update and prioritize assumption-driven research needs by 2020

Goal 5b: Active engagement by key research professionals in assumption testing and other applicable research for each bird guild and human science in both BCRs

Priority A

Actively seek opportunities to increase research funds available through and to LMVJV partners

Change from 2020: **Improved**

JV staff and Science Team have established priorities for research funding in the near term, and continue to develop an approach to setting realistic priorities into the future through the 2022 Science Priorities document.

LMVJV staff have been successful in facilitating increased funds to Univ. Arkansas Monticello (Dr. Doug Osborne) marsh bird research project, NFWF funding to SFASU (Dr. Rebecca Kidd), Mississippi State Univ. (Dr. Kristine Evans) landscape scale planning assessment, and RCPP research funds in the WGCP of Arkansas and Louisiana for open pine, native prairie, bird, and social science.

Priority B

Maintain and continue to build the depth and breadth of research scientist participation in LMVJV-relevant research topics

Change from 2020: **None**

Outreach to universities and other organizations by LMVJV Staff continues. As JV science priorities are maintained and addressed, and working groups are formed, further outreach will continue.

Currently working with the following:

- Dr. Dan Saenz of USFS Southern Research Station (Nacogdoches, TX) on songbird response to NE Texas HIP program prescribed fire and songbird response to MAV forestry practices through a NFWF grant
- Dr. Rebecca Kidd (Stephen F. Austin State Univ.) on forest breeding bird response to WRE(P) reforestation in the MAV
- Dave Holdermann (TPWD) on waterborne bird surveys for bottomland hardwood priority bird species
- Dr. Hans Williams (Stephen F. Austin State Univ.) on evaluation of bottomland hardwood assessments associated with water development activities in the WGCPO
- Dr. Kristine Evans (Mississippi State Univ.) on assessment of SE JV and SECAS Blueprint outputs
- Dr. Don White (University of Arkansas Monticello) regarding habitat suitability indices for Prothonotary Warblers on White and Cache Rivers
- Dr. Ashley Gramza (Playa Lakes Joint Venture) regarding human dimensions of Farm Bill program participation
- Dr. Elena Rubino (University of Arkansas Monticello) regarding human dimensions of Farm Bill program participation

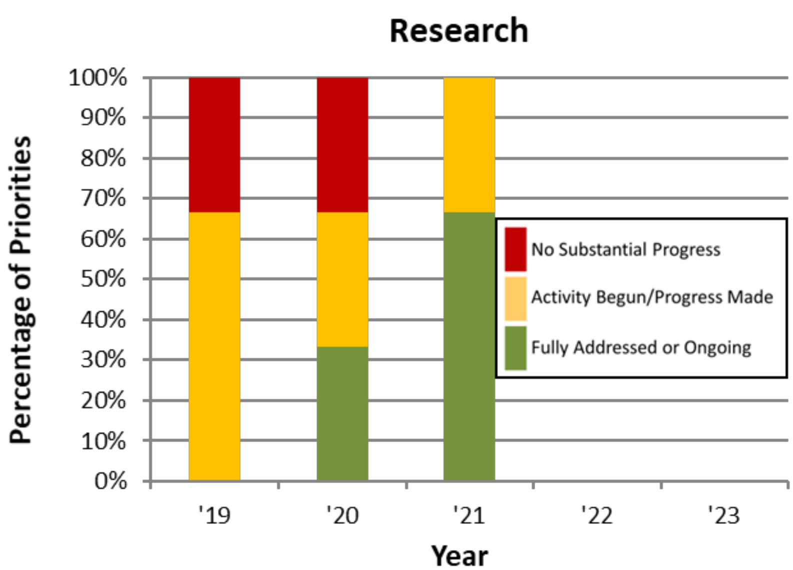
Research (cont'd)

Priority C

Improve understanding of private landowner participation in conservation programs

Change from 2020:
Improved

Work through and funded by the AR-LA Open Pine RCPP will address landowner hurdles and enticements to participation in Farm Bill programs and adoption of practices.



Year 3 ('21) Priorities Status

Increase Research Funds†
Build Research Scientist Participation
Understand Priv. Landowner Participation†

†Change since 2020

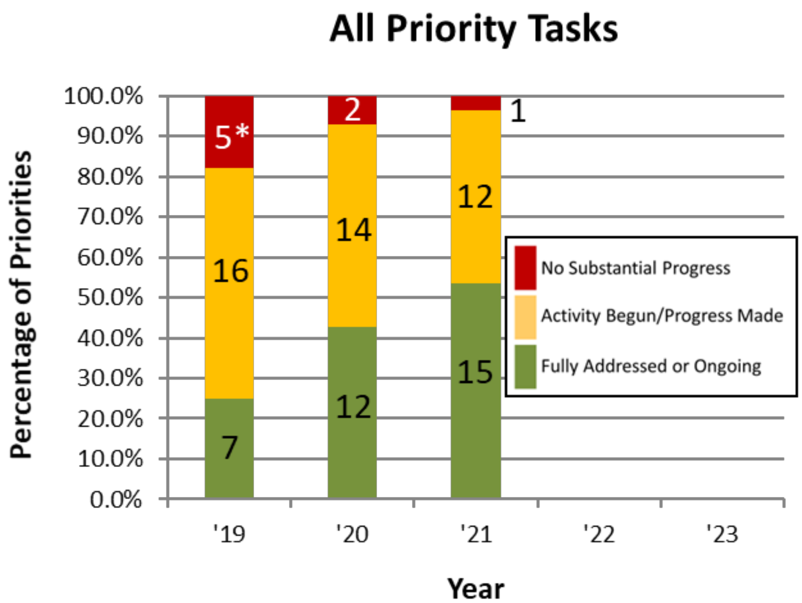
Communication, Education, and Outreach

Goal 6a: Address priority actions detailed in the 2014 LMVJV Communications Plan

Goal 6b: Revise/update 2014 Communications Plan as appropriate by 2023

Priority A Effectively address Communications Plan priority actions	See "Organizational Performance" Priority C. Complete assessment of Communications Plan priorities underway, and will be addressed elsewhere
Priority B Update Communications Plan by 2023	Updated Communications Plan approved by Management board 21 October 2020.

Overall Progress



*Number of tasks within category

Communication

LEADERS ON THE LAND

*The Lower Mississippi Valley Joint Venture (**LMVJV.org**) exists to collaborate in the protection, restoration, and management of birds and their habitats in the Mississippi Alluvial Valley and West Gulf Coastal Plain/Ouachitas regions.*

From the Joint Venture Coordinator and Chair

Late Summer brings many predictable things. Unfortunately, for many of our partners and families it brought Hurricane Ida. The storm tide, wind, and rain have proven destructive to our colleagues and friends in their path, and we want to remember them in our thoughts, prayers, and through helping hands as they recover.

Before temperatures and humidity finally fall, many of us anticipate the coming of autumn through a host of activities, not least of which is putting finishing touches on fields and wetlands prepared for hunting, birding, and enjoying time with family. In this issue we again highlight, in our **Private Landowner Spotlight**, a private lands conservation champion who has been managing and preparing habitats in northeast Texas for many years. We also highlight a brand new assistance opportunity in **JV Partnership in Action** that will help private landowners improve pine and associated grassland habitats for numerous wildlife species in Arkansas and Louisiana. And as we eagerly wait for cooler weather and the arrival of birds we haven't seen in a while, our **Hands-on Guidance** section

Lower Mississippi Valley
Private Landowner Conservation Champion
JOINT VENTURE

Private Landowner Spotlight

Keith Alford (Meridian Forestry), Sean Willis (Texas Parks & Wildlife Department), and Craig Whealy at the entrance to White Rock Pasture.

Craig Whealy & White Rock Pasture

White Rock Pasture is an 11,500-acre property in Trinity County, Texas, owned by Red Town Timberlands. Since 2001, Craig Whealy's Meridian Forestry has actively managed the farm for wildlife and timber. In 2007, they received TPWD's Lone Star Land Steward Award, which recognizes private landowners for outstanding contributions to natural resource conservation and management and is meant to promote long-term conservation of unique natural and cultural resources. While the property is managed as commercial timberlands, the owner has a strong interest in wildlife management, particularly describes a resource for land managers with useful information for providing shorebird habitat in the fall. This section also provides information and resources for native understory conservation in pine forest. In **Opportunities** we help connect readers with resources that can directly assist in achieving management goals, and the **Meet Our Staff & Partners** section highlights two people who are helping many landowners access those resources. Finally, you'll find a round-up of interesting and useful news items in the **Conservation in the News**. We sincerely hope that you and yours are well, and well on your way to enjoying the fruits of fall!

Jeff Raasch
LMVJV Management Board Chair

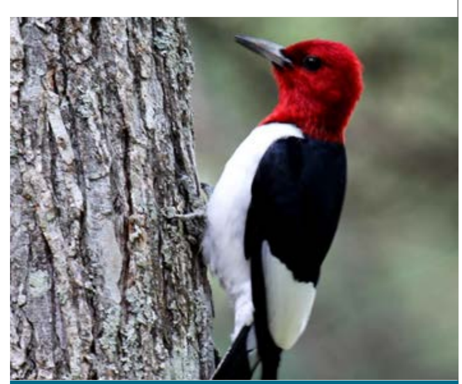
Keith McKnight
LMVJV Coordinator & *Leaders on the Land* Editor

for deer and turkey, and has allowed Meridian Forestry to work closely with TPWD wildlife biologists to improve habitat. The property is leased for recreational deer hunting and has had some permitted alligator harvests over the years. Bottomland habitat along White Rock Creek provides habitat for waterfowl, particularly nesting wood ducks. A unique prehistoric oyster reef with petrified oyster shells believed to be 40 million years old is also located on a portion of the property along White Rock Creek.

Habitat improvements are abundant and include
- day-lighting roads
- understory control using both herbicide and prescribed fire
- conversion of logging sets to wildlife openings
- retention of hardwood stands

Improvements in the habitat led to the property being approved as an Eastern Turkey Super Stocking Site in 2015, and between 2015-2016 it was stocked with 80+ wild trapped Eastern Turkeys as part of a restoration project by TPWD. The owners collaborated with TPWD and Stephen F. Austin State University staff to conduct nesting and brood research by tracking GPS-marked hens. TWPD also conducts gobble counts and brood survey routes to monitor the restoration efforts.

In 2016, a NWTF Hunting Heritage Super Fund project converted 29 old logging sets to permanent wildlife openings to provide nesting and brood habitat for turkeys, and in 2018 researchers at Louisiana State University began analysis of the GPS data collected in 2015-2016. In 2018, White Rock completed a Neches River Habitat Incentive Program/NWTF project (part of the LMVJV's NETX Conservation Delivery Network [CDN] efforts) to chemically control the understory on 14 stands totaling 537 acres. In 2019, a NETX CDN Habitat Incentive Program project funded burning on approximately 15 stands totaling 672 acres.



Red-headed Woodpecker by James D. Childress

Mr. Whealy and Red Town Timberlands have consistently sought technical guidance from TPWD and have been extremely accommodating to staff for access to their property for monitoring, research, and collection of data. Continued focus on understory control using herbicide and prescribed burning are not only improving timber production and habitat for deer, they are also providing critical nesting and brood habitat for turkeys, and quality habitat for multiple bird species and pollinators that thrive in open pine habitats.

JV Partnership in Action

Regional Conservation Partnership Program (RCPP)
Open Pine Landscape Restoration in Arkansas & Louisiana

Partners in the **Arkansas-Louisiana Conservation Delivery Network** (AR-LA CDN) are bringing new resources to private landowners within 16 counties and parishes of north-central Louisiana and south-central Arkansas. The LMVJV's AR-LA CDN Open Pine Landscape Restoration partnership has secured $5.9 million over five years from the Natural Resources Conservation Service (NRCS) to conserve species of conservation concern across 30,000 acres of private lands within the delivery area.

This RCPP, administered by the American Bird Conservancy, strategically focuses on priority conservation zones in the West Gulf Coastal Plain historically dominated by shortleaf pine. Farm Bill Conservation and other resources (technical and financial) will be available to landowners for critical habitat conservation practices such as invasive species control, forest stand improvement, prescribed burning, and native vegetation establishment within pine and mixed pine/hardwood forest and connecting right-of-way habitats.

The CDN, including 19 partners, will use several innovative tools and approaches to target conservation funds on lands important to species such as Northern Bobwhite, Henslow's and LeConte's sparrows, Louisiana Pine Snake, Red-cockaded Woodpecker, Eastern Wild Turkey, and many more. Partners are bringing an additional $8 million to the table to assist in delivery of the program, monitor important outcomes, and ensure effective outreach and communication to potential cooperators. Bill Bartush (LMVJV Partnership Coordinator), Ricky Chastain (Arkansas Game & Fish Commission), and David Breithaupt (Louisiana Department of Wildlife & Fisheries) are working through many other CDN partners and NRCS leadership in Arkansas and Louisiana to help make this important project a reality - proving that Partnership Really Does Pay!

LeConte's Sparrow by K. Niyo, USFWS

Opportunities!

Longleaf prescribed fire grant: Applications to the Texas Longleaf Implementation Team for **prescribed fire assistance** are currently open and due by *Thursday, September 30th.* **Apply here**.

Farm Bill's Feral Swine Eradication & Control Pilot Project
USDA is accepting applications from non-federal, not-for-profit partners for projects to help agricultural producers and private landowners trap and control feral swine, which is part of the Feral Swine Eradication and Control Pilot Program (FSCP). Projects include swine removal by APHIS, habitat restoration, and assistance to producers for feral swine control. Deadline to apply Nov. 5, 2021.
Learn more here.

NRCS-Louisiana staff discuss conservation activities with Private Landowner Conservation Champion, Dr. Johnny Armstrong.

Landowner Assistance, by state, within the Lower Mississippi Valley
Numerous technical and financial assistance opportunities are available to private landowners in the LMVJV region. Some of the most relevant of these are detailed on the **LMVJV's Landowner Assistance page**. Many programs are federal, but vary by state. Others are state programs funded through fish and game agencies or others, but terminology varies from state to state. Regardless, they are all focused on providing resources and/or technical assistance to landowners who want to manage habitat for wildlife.

Northern Bobwhite by James D. Childress

The National Bobwhite Technical Committee is proud to announce the long awaited, highly anticipated eastern grazing strategies document, ***Beef, Grass, and Bobwhites – Quail Management in Eastern Native Warm-Season Grass Pastures***. This technical bulletin, funded by Working Lands for Wildlife, is targeted to technical advisors working with cattlemen and women in the eastern U.S. who are interested in managing for bobwhites. The authors combine a review of the literature, current research and first-hand experience to present this first-of-its-kind technical manual integrating grazing and bobwhite management in the eastern U. S. **Preview the report here**, or place a **pre-order for your copy here**.

Regional Conservation Partnership Program Open Pine Landscape Restoration in Arkansas & Louisiana
As noted on p. 3, the RCPP has been approved and is in the establishment phase. Expect an announcement from NRCS late in 2021 with a fact sheet and timelines; a process and further information will be provided at the **LMVJV Landowner Assistance page** to guide interested landowners to the appropriate resources and county/parish NRCS contacts.

Shortleaf Pine Cone

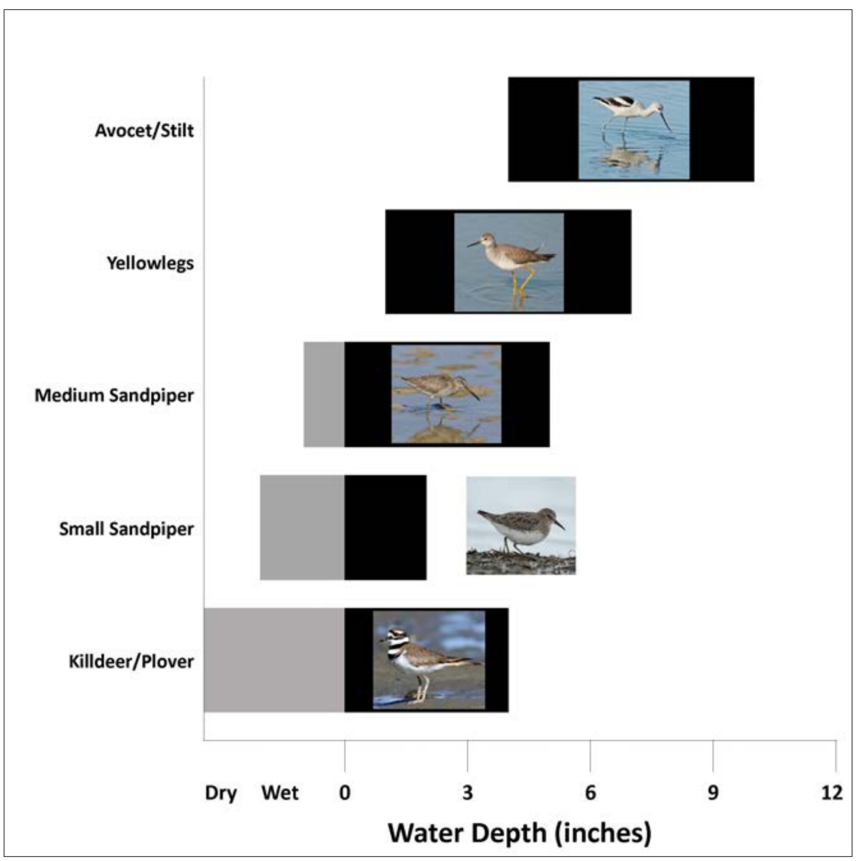
Hands-On Guidance

Shorebird Management Manual

How many of us can say they've seen a bird that flies 14,000 (or more) miles in migration every year of its life – up to 3,000 in a single flight? Well, probably most of us! If you've spent much time around fresh, shallow water during spring or late summer in this part of the world, chances are you've seen a Semipalmated Sandpiper. Most know them simply as 'sandpipers' or 'peeps'. Whatever you call them, their ability to make a living in wetlands from Alaska to South America is nothing short of amazing. And it's what they are doing on our mudflats and shallow wetland edges that is of interest to biologist- and landowner-conservationists alike. These habitats supply the fuel (mostly aquatic insects) that they, their look-alike sandpiper cousins, and other shorebirds, need to get from their Arctic breeding grounds to winter havens in South and Central America, and back again.

Semi-palmated Sandpiper by James D. Childress

Managing for most shorebirds is straightforward, but not necessarily easy, especially during the challenging southward (late summer/fall) migration. With relatively short legs and the need to keep an eye out for aerial predators, most small shorebirds require wetlands with moist mud to only a couple inches of water, and little (if any) standing vegetation.



Luckily, helpful management resources are close at hand. The latest **comprehensive shorebird habitat management guide** (**https://bit.ly/manomet-shorebird-mgmt**) was recently published by Manomet (**manomet.org**), covering the spectrum of shorebird needs across the Western Hemisphere, with practical guidance to land managers (see pp. 43-48, and the Sherburne WMA, LA, Case Study pp.141-145). The LMVJV's Shorebird Plan Summary also provides management recommendations for shallow wetlands, aquaculture ponds, rice fields, and other agricultural fields. Both documents can be found on the **LMVJV Shorebird Plan page** (**lmvjv.org/shorebird-plan**).

Native Plants Under a Pine Canopy

Production foresters have long understood the reality of tree competition for light and applied that knowledge to forest management plans. Tree density and spacing through the life cycle of a forest stand are key to maximizing growth and yield. This same light, and competition for it, is key to management of forest stands to provide quality wildlife habitat as well.

Habitat management recommendations for many forest wildlife species call for canopy gaps, which allow generous amounts of sunlight to reach the forest floor and enable the growth of native grasses and forbs. This is the first key ingredient for providing good habitat in pine and mixed pine/hardwood stands for game species such as Northern Bobwhite, Eastern Wild Turkey, and deer. It's also critical to support a host of songbirds, such as Bachman's sparrow and Prairie Warbler, as well as bees, butterflies, and other pollinators. These critters are without a doubt in the forest, but they are making a living mostly from the food and cover provided by this healthy undergrowth of "groundcover."

You can find excellent information about common, important understory plant species within the LMVJV region at the Texas Longleaf Implementation Team website (**txlongleaf.org**) under **Landowner Assistance, Ecosystem Management**.
However, panic grass, bluestem, and milkweed are not the only plants that respond to the sunlight! Without the application of frequent fire, woody species quickly begin to shade out most of the wildflowers and grasses. Providing quality wildlife habitat within pine stands is a function of maintaining a moderately open canopy (generally, 30-70% Canopy Cover) coupled with the frequent application (every 2-3 years) of prescribed fire. Both Longleaf and Shortleaf Pine are especially equipped to thrive under such a management approach.

Your nearby state and federal wildlife agency private lands biologists (**lmvjv.org/landowner-assistance**) can help you develop, refine, and execute a management plan for keeping a healthy native understory community within your upland forest stands. They may even be able to point you toward potential financial assistance for some of these activities. Maintaining a pine forest with open canopy and fire-enabled native understory will provide wildlife sights and sounds you may not have thought possible. And some of our highest priority species will be better off for it!

Photos courtesy of James D. Childress. Top to bottom: Butterfly weed, female Diana Fritillary, and Bachman's Sparrow

Conservation in the News

Flooded Fields for Shorebirds and More in Mississippi
Delta Wind Birds and private landowners in the Delta region of Mississippi are discovering that shallow fall/winter flooding on corn fields not only benefits birds, but early evidence suggests it conserves soil, keeps excess nitrogen out of streams, and may improve subsequent crop yield. Read more.

Growing Wildlife Managers in Cass County, TX—One Family at a Time
Learn how one family in Cass County, TX was inspired by a shortleaf pine tour hosted in 2017 by the Joint Venture, which eventually led to restoration workshops and the establishment of a landowner wildlife cooperative. In 2021, the family received an award from the Marion-Cass Soil and Water Conservation District (SWCD) for their ongoing contributions to local conservation efforts. Read more.

Arkansas Game and Fish Commission Makes Decision to Change Greentree Reservoir Management for the Benefit of Wildlife, Current and Future Waterfowlers
GTR renovations will be completed across 16 Arkansas WMAs, initially with help from a NAWCA grant and LMVJV partners. GTR management plans will be revised to provide a more natural flooding and flow regime by:

- delaying intentional flooding each year until after mid-November to prevent extra stress that trees experience from floodwater before they are fully dormant;
- incorporating flexibility in water management to allow year-to-year variability and a more cyclical five- to seven-year flood cycle. Read more.

Hunting Element Requirement of Federal Duck Stamp Removed
Beginning with the 2022 Federal Migratory Bird Hunting and Conservation Stamp Contest (Federal Duck Stamp Contest), artists will no longer be required to include an appropriate hunting element within contest entries. Established in 1934, all U.S. waterfowl hunters who have attained the age of 16 are required to buy an annual Federal Duck Stamp. Funds generated from stamp sales are used to protect waterfowl and wetland habitat that is incorporated into the National Wildlife Refuge System. Read more.

Art work by Mark Anderson

Forest Markets - A Key Component of Successful Habitat Management
The Tri-state Conservation Partnership (TCP) continues to work in support of habitat management and Desired Forest Conditions for Wildlife (DFCW) through collaboration and coordination with the forest products industry and wood suppliers in the MAV. Read more.

Are you subscribed yet? SIGN UP for *Leaders on the Land* quarterly by email at bit.ly/LeadersOnTheLand

If you are reading a hard copy, you can access this newsletter and all its internet links by going to www.lmvjv.org/leaders-on-the-land on the web.

Meet Our Staff & Partners

Bill Bartush, WGCPO Partnership Coordinator (staff)

Bill's primary role is to provide coordination and communication assistance to partners in pursuit of LMVJV bird habitat objectives in the West Gulf Coastal Plain/ Ouachitas region. He works out of Tyler, TX. Contact: bbartush@abcbirds.org, 903-570-9626

Annie Farrell, NWTF (partner)

Annie currently serves as District Biologist for Texas, Oklahoma, Kansas, and Nebraska for the National Wild Turkey Federation, and is an integral part of the leadership team for the Northeast Texas Conservation Delivery Network. She works out of Lindale, TX. Contact: afarrell@nwtf.net, (903) 539-0279

Acronyms

AGFC - Arkansas Game and Fish Commission
CDN - Conservation Delivery Network
DFCW - Desired Forest Conditions for Wildlife
FSCP - Feral Swine Eradication and Control Program
GTR - Greentree Reservoir
HIP - Habitat Incentive Program
JV - Joint Venture
NRCS - USDA Natural Resources Conservation Service
NAWCA - North American Wetlands Conservation Act
NWTF - National Wild Turkey Federation
RCPP - Regional Conservation Partnership Program
SWCD - Soil & Water Conservation District
TCP - Tri-state Conservation Partnership
TPWD - Texas Parks & Wildlife Department

Science

Waterfowl Conservation in the LMVJV

Summary Report to the NAWMP Plan Committee
August 2021

I. The LMVJV Landscape

NATURAL RESOURCES AND THREATS

The Lower Mississippi Valley Joint Venture (LMVJV) consists of two Bird Conservation Regions (BCR); the Mississippi Alluvial Valley ("MAV"; BCR 26) and the West Gulf Coastal Plain & Ouachitas ("WGCPO"; BCR 25), comprised of portions of eight states (Figure 1). Although adjacent to one another, these two ecological regions differ significantly in social, economic, agronomic, and natural influences. As a result, conservation priorities and approaches are relatively dissimilar.

Figure 1. Forested wetland habitat distribution within the West Gulf Coastal Plains & Ouachitas and Mississippi Alluvial Valley Bird Conservation Regions of the LMVJV.

<u>MAV</u> -- The MAV was historically dominated by bottomland hardwood forest, interspersed by a few significant areas of native prairie (e.g., Grand Prairie of Arkansas) and upland pine (e.g., Crowley's Ridge). As a result of its expansive flood-prone forests, the MAV is a historical corridor for migration and

winter terminus for ducks (Mallard, Gadwall, Green-winged and Blue-winged Teal, American Wigeon, Northern Shoveler, Northern Pintail), as well as an important breeding area for Wood Ducks. However, most of the original bottomland hardwood forest has been converted to row crop agriculture (Figure 2). Whereas naturally-flooded forest still provides significant feeding, resting, and breeding habitat for ducks, managed shallow emergent wetland (i.e., moist-soil) and flooded grain crops now account for a substantial amount of food energy found in this region.

Conversion to non-habitat (i.e., cotton, non-flooded cropland, development) along with further direct alteration of surface (levees, diversions) and subsurface (pumping) hydrology, as well as indirect shifts in hydrology due to climate-driven changes in precipitation and agriculture are among the most pressing threats to waterfowl habitat within this system. Because of the pervasive influence of agricultural activities within the MAV, land use and conservation opportunities and threats within this region are sensitive to agricultural (and related) policy.

<u>WGCPO</u> -- The WGCPO is composed of the Ouachitas Mountains and West Gulf Coastal Plain ecological regions. Both regions historically were heavily dominated by native upland pine and mixed pine/hardwood forest. These uplands were interspersed with rivers, their floodplains, and smaller streams in the West Gulf Coastal Plain, whereas the Ouachita Mountains were characterized by smaller streams with narrow riparian zones. The contemporary landscape is similar, but with significant portions of upland forested habitat converted to pasture, urban development, and silviculture using off-sight pine, with much of the forested wetland impacted by clearing on the higher elevations and inundation from major reservoirs in the lower elevations. Several river systems in the West Gulf Coastal Plain produce fairly extensive floodplain forests and wetlands (e.g., Arkansas River, Boeuf River, Ouachita River, Red River, Sabine River, Trinity River; Figure 3) that are important to waterfowl as non-breeding (e.g., Mallard, Green-winged Teal) and breeding (e.g., Wood Duck) habitat. The major threats to remaining waterfowl habitat include hydrological alteration (especially reservoir construction and expansion), and conversion of forested wetland to other land uses.

PLANNING GOALS & OBJECTIVES

Habitat goals and objectives for waterfowl in both BCRs are based on the assumptions that food during the non-breeding season is the limiting factor, and that coarse-scale distribution of food resources (i.e., among states within BCRs) is sufficient to meet their needs. Waterfowl population goals are stepped down directly from NAWMP continental goals, using accepted methodologies. Habitat objectives are expressed as Duck Energy Days (DEDs), and are calculated based on a series of assumptions regarding availability and energy density of common foods in naturally flooded, privately managed "in project" (i.e., under formal agreement), privately managed "out of project" (i.e., no formal agreement), and public managed habitats. Human objectives have not been established, but when developed are expected to relate to (1) improving acceptance/delivery of clearly important conservation practices/programs, and (2) enhanced/increased recreational opportunities.

GOVERNANCE & BUDGET

The organizational structure of the LMVJV is composed generally of a Management Board, JV Support Office, Working Groups, and Partner Organization Staff. Each of these entities has unique and specific roles and functions, consistent with the priorities of the Joint Venture. However, identifying and filling critical capacity gaps is the responsibility of the entire partnership, such that making decisions on how and by whom various functions are filled depends upon the strengths and weaknesses in both Partner and Support Office capacity.

Management Board & Governance -- The Lower Mississippi Valley Joint Venture is overseen and directed by a 17-member Management Board representing eight state conservation agencies, four non-profit organizations, and four federal agencies (two USFWS legacy regions have separate representation; Table 1). The Management Board membership includes agencies or organizations, which by virtue of mission or legislative authority, commit to sharing in the responsibility of implementing national and international bird conservation plans within the LMV region. Member organizations are expected to commit/dedicate time, energy and resources to developing a shared-vision of bird conservation for the LMV and coordinating their otherwise independent actions in the cooperative pursuit and refinement of that vision.

It is the role of the Management Board to set the broad direction and priorities for the partnership's shared activities. The Board meets twice annually in scheduled business sessions (in-person, with the exception of recent COVID-19 travel/meeting restrictions; Spring & Fall). Priorities for collective action of the LMVJV partnership are enumerated in a 5-year operational plan, ***LMVJV Operational Plan 2018-2023 for a Landscape Supporting Healthy Native Bird Populations Across the LMVJV*** ("Operational Plan"; https://www.lmvjv.org/s/LMVJV-Operational-Plan-2018_FINAL-10-17-18.pdf). Communication and Outreach priorities are described in our 5-year communications plan, ***Lower Mississippi Valley Joint Venture Communications Plan for a Landscape Supporting Healthy Native Bird Populations Across the LMVJV (2020)*** (https://www.lmvjv.org/s/LMVJV-Communications-Plan-2020.pdf). Board membership, function, and protocols are guided by the Organizational Performance element of ***Desired Characteristics for Habitat Joint Venture Partnerships*** ("JV Matrix"; Operational Plan, Appendix A), and LMVJV Operational Procedures (Operational Plan, Appendix B).

Table 1. Composition of the Lower Mississippi Valley Joint Venture Management Board, August 2021.

Organization	Position of Current Member
American Bird Conservancy	Vice President for Operations
Arkansas Game and Fish Commission	Assistant Wildlife Division Chief
Ducks Unlimited	Director, Conservation Programs (MS, TN, AR, LA, AL)
Kentucky Department of Fish & Wildlife Resources	Wildlife Division Director
Louisiana Department of Wildlife and Fisheries	Chief, Wildlife Division
Mississippi Department of Wildlife, Fisheries, & Parks	Executive Wildlife Director
Missouri Department of Conservation	Wildlife Management Chief-Ozark Unit
National Wild Turkey Federation	District Biologist (AR, LA, MS)
Oklahoma Department of Wildlife Conservation	Senior Biologist
Tennessee Wildlife Resources Agency	Wildlife Program Manager, Region 1
Texas Parks and Wildlife Department	Statewide Wetlands/Joint Venture Program Coord.
The Nature Conservancy	Director, Lower Mississippi River Program
US Fish and Wildlife Service (Albuquerque)	Chief, Migratory Birds
US Fish and Wildlife Service (Atlanta)	Deputy Regional Director
US Geological Survey	Deputy Dir., SC Climate Adaptation Science Center
USDA Forest Service, Region 8	Forest Supervisor, Kisatchie NF
USDA Natural Resource Conservation Service[1]	State Conservationist, Arkansas

[1] Non-voting

Joint Venture Support Office -- The Support Office's responsibility is to facilitate timely accomplishment of priorities through day-to-day coordination and attention. While the Joint Venture Support Office may from time to time receive funding and staff from other partners, the Office operates as a field station of the U.S. Fish and Wildlife Service, in the service of the LMVJV Management Board. This Joint Venture is staffed by professional positions (Table 2) focused on our unique geographies and functional responsibilities outlined in the JV Matrix.

Table 2. LMVJV Support Office staff, current as of August 2021.

Position Title	Staff Member	Employer
Coordinator	Keith McKnight	USFWS
Office Administrator	Linda McHan	USFWS
Science Coordinator	Anne Mini	American Bird Conservancy
GIS Applications Biologist	Blaine Elliott	USFWS
MAV Partnership Coordinator	Steve Brock	USFWS
WGCPO Partnership Coordinator	Bill Bartush	American Bird Conservancy

In addition to these full-time positions, the LMVJV currently contracts communications assistance (newsletters, news releases, web content updates, technical document summaries, etc.) through a private consultant. The Joint Venture Coordinator and associated staff are responsible for facilitating, guiding, and leading the various working groups created by the Board to pursue all facets of Joint Venture implementation.

Technical Working Groups -- Management Board representatives engage their professional and technical staff in the various facets of Joint Venture implementation through the forum of permanent or *ad hoc* Working Groups, Teams, Conservation Delivery Networks, and/or other networks and active partnerships (Table 3).

Table 3. LMVJV working groups, current as of July 2021.

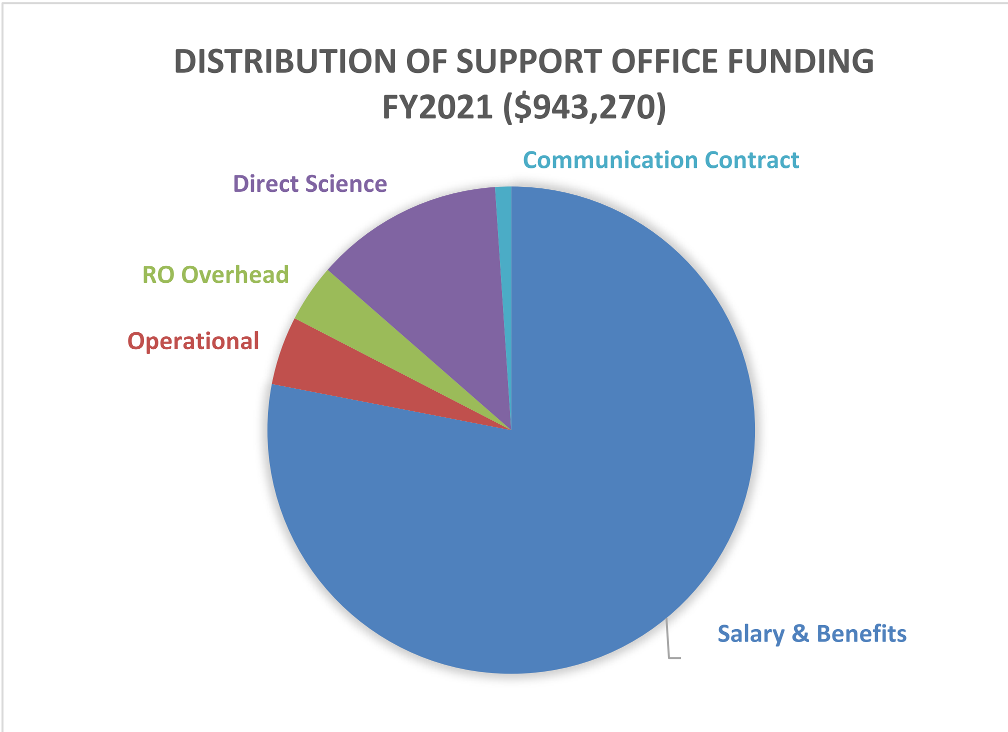
Category	Working Group
Technical	Science Team
	Waterfowl Working Group
	MAV Landbird Working Group
	WGCPO Landbird Working Group
	Shorebird Working Group
	Waterbird Working Group
	Forest Resources Conservation Working Group
	Human Dimensions Working Group
Delivery	Arkansas MAV Conservation Delivery Network
	Arkansas-Louisiana WGCP Conservation Delivery Network
	Louisiana-Mississippi Conservation Delivery Network
	Northeast Texas Conservation Delivery Network
	Tri-State Conservation Partnership
	Private Landowner Conservation Champion Selection Team
Administrative	Communications Plan Working Group
	Operational Plan Working Group

Importantly, many of these working groups and teams generally are open to individuals from any organization (i.e., not only Management Board organizations) with the understanding that their interests and expertise are consistent with LMVJV needs and priorities (see Table 4).

Table 4. Non-Management Board organizations participating in LMVJV working groups.
Arkansas Cooperative Fish & Wildlife Research Unit
Arkansas Forestry Commission
Arkansas Natural Heritage Commission
Arkansas Natural Resources Commission
Audubon
Black Bear Conservation Coalition
Caddo Lake Institute
Central Hardwoods Joint Venture
Colorado State University, Center for Environmental Management of Military Lands
Delta Wildlife
Delta Wind Birds
East Gulf Coastal Plain Joint Venture
Forest Resource Consultants, Inc.
Gulf Coast Joint Venture
Hancock Forest Management
International Paper
Louisiana Cooperative Fish & Wildlife Research Unit
Louisiana Department of Agriculture and Forestry
Louisiana State University
Louisiana Tech University
Manomet
Mississippi Forestry Commission
Mississippi State University
Patuxent Wildlife Research Center
Quail Forever
Stephen F. Austin State University
Texas A&M Forest Service
The Conservation Fund
U.S. Department of Defense - Ft. Polk
University of Arkansas, Monticello
Wildlife Mississippi

Budget -- The LMVJV receives approximately 5.9% of USFWS 1234 funds annually to support staff and other Support Office expenses. In FY2021 this amount was $842,000. In addition to these funds, the LMVJV annually receives and administers $100,000-200,000 in funds from partner organizations (contributed funds, cooperative agreement, intra-agency agreement) and grants to support the work of the Joint Venture.

It is important to note that our support office staff work directly with partners and funders to facilitate the flow of tens of millions of dollars annually directly to partners in support of the LMVJV mission (e.g., Wetlands Reserve Enhancement Program, Regional Conservation Partnership Program, NFWF). These dollars are used to fund on-the-ground project work, increased capacity, communication and outreach, and other actions in support of LMVJV priorities.



II. Approaches to Setting Step-Down Objectives

Populations and Habitat: Approach, Rationale, Assumptions, etc.

Past effort (2015 and prior)

The primary assumption in the LMVJV's approach to waterfowl conservation is that food energy during the non-breeding season is the limiting factor. For our 2015 effort, we used the 1970s distribution of waterfowl populations (M. Koneff, unpublished data) to derive objectives. We assumed a 110-day wintering period to translate population objectives into Duck Energy Day objectives, adjusted for a 15% winter mortality and a proportion of ducks wintering in Mexico (*Reinecke and Loesch 1996; LMVJV 2007*). We included geese in our model as 'competitors' (*Edwards et al. 2012*).

We used a bioenergetic model to complete the 2015 stepdown objectives and develop habitat objectives, calculating energy supply on the landscape for 3 habitat categories – areas subjected to natural flooding, private managed land, and public managed land.

- For natural flood, we calculated the extent, habitat type, and frequency of flooding.
- For managed private land, we calculated extent, habitat type, status and disturbance.
- For managed public land, we calculated extent, habitat type, performance, and disturbance.

Extent – For naturally flooded and managed private land, the acres of each category were calculated through remote sensing overlaid with water on the landscape. For public lands, we maintain a geospatial database (Water Management Unit database) into which partners enter detailed information; acres of habitat are automatically generated from the database.

Habitat type-- We assigned Duck Energy Day values to seven major habitat types: moist-soil, rice (harvested/unharvested), soybean (harvested/unharvested), corn (harvested/unharvested), milo (harvested/unharvested), millet (unharvested), and forested wetlands (percent red oak component) based on expert recommendations (Reinecke and Kaminski, unpublished data). For naturally flooded and managed private land, we used a crop data layer to assign habitat type inundated by water. For public land, we used the Water Management Unit database to determine habitat type.

Frequency of flooding -- We assumed that habitat needed to be flooded for at least one day to be accessible to and used by waterfowl. We used satellite imagery scenes from winter periods to assess water on the landscape, and Monte Carlo simulation to determine flooding scenario most likely to occur 80% of the time in each watershed.

Status (private managed) – Geospatial information on land managed through a conservation program (e.g., WRP/E, Partners for Fish and Wildlife, etc.) was obtained directly from partners and the Protected Areas Database. We additionally calculated, based on a square water algorithm, whether land was likely managed outside of a conservation management program (e.g., duck club not enrolled in WRP/E).

Performance (public land) – We used remoted sensing to assess, on average, how often full pool capacity was reached for each agency (state or federal) within a state.

Disturbance -- We assumed that hunting-related disturbance affects the availability of energy to waterfowl

Current effort

For population objectives, we arrived at a decision to use the 80th percentile of waterfowl populations from the dual objectives of the 2012 NAWMP and 2014 guidance document. Specifically, the Gulf Coast JV and LMVJV agreed that the long-term average objective should be viewed as an alarming level that, if not consistently exceeded by habitat conditions, would trigger increased, concerted actions to accelerate conservation efforts. The 80th percentile is viewed as the objective we strive to achieve every year, while recognizing the need to preserve landscape conditions capable of periodically providing habitat above this level. [*see https://www.lmvjv.org/s/GC-LMV_Joint_report_pop_obj_2018.pdf*]

Based on partner recommendations since 2015, we have moved forward with updating our modeling effort, which will begin in earnest in 2022. Updates will include the following:

- Switch modeling platforms to the TrueMet platform (versus an Excel spreadsheet).
- Model both waterfowl migration chronology and habitat availability over the course of time (no longer using a static time period)
- We have updated our DED values based on current literature and other research
- We have developed a more sophisticated flood modeling approach that looks at flood inundation over a longer time frame versus a single snapshot of a winter water scene (prior approach)

- Use eBird data and STEM models to develop migration chronology
- We have revised our geospatial database (Water Management Unit database) to reflect the habitat within public lands impoundments more accurately

Populations and Habitat: Issues and Challenges

In the course of our modeling update, we will have several uncertainties to address. Each of the following presents its own challenges.

- Uncertainty in our characterization of natural flooding
- Provision of unharvested crops on private land
- Sanctuary availability and the role of sanctuary on private land and public land
- Reassessment of the amount of goose competition for duck resources
- Waterfowl distribution in relation to energy on the landscape and habitat complexes

Our partnership allocates NAWMP goals based on the current distribution of habitat provision from state agencies, federal agencies and private land within each state. For example, a federal agency currently providing 50% of the energy on the landscape within the state is assigned 50% of the NAWMP goal for that state. These state-level objectives then can be allocated to individual WMA and/or NWR objectives. State and federal partners were encouraged to work together to do so, providing JV Office assistance where desired. A series of meetings were convened to discuss useful approaches to allocating objectives at this finer scale. Based on the *Strategic Action Plan for Waterfowl in the Southeast Region*, the USFWS Southeast Region set NWR-specific DED goals for the entire region. The Joint Venture will continue to coordinate with the Southeast Region Waterfowl Biologist, Heath Hagy, and NWRs on their objective setting process, monitoring, and other action items from the Strategic Action Plan.

It is important to note that we set two types of habitat objectives – a maintenance goal and an aspirational goal. The maintenance goal emphasizes the imperative of maintaining current habitat. States below their NAWMP goal took on an aspirational goal to highlight the needed land management and/or acquisition to make up the DED difference. However, we consistently received feedback from partners that even maintaining high quality waterfowl habitat was difficult without adequate staff, equipment and funding.

For waterfowl, we do not currently have spatial priorities (at finer resolution than state, such as county or watershed). Without spatial priorities, we cannot evaluate the distribution of waterfowl habitat provision (as suggested by PC guidance).

People: Approach, Rationale, Assumptions, etc.

Initial efforts to address human dimensions/people objectives of NAWMP were begun by a subset of the Waterfowl Working Group in November 2019. This group discussed the most potentially fruitful approaches for the LMVJV.

1) Private Lands Conservation -- The most straightforward issue in this context is determining how to maintain and increase waterfowl-friendly habitats and remove barriers to enrollment in conservation programs. An important example is fall tillage of rice fields, and programs to incentivize no-till practices. The Arkansas Waterfowl Rice Incentive Program (WRICE) through the Arkansas Game and Fish Commission (AGFC) provides an important opportunity to learn

about this aspect of private land conservation. This is one of the most important types of working land that can translate to waterfowl habitat. AGFC will continue work on increasing persistence of conservation practices after program termination. The LMVJV community will work in cooperation with AGFC to refine, and potentially duplicate this approach outside of Arkansas.

A general synthesis of what is known about salient components (e.g., hurdles, motivations, effective communication) of private lands conservation in the Southeast could be a helpful tool for the LMVJV. Specifically, a review of all tillage practices, rice production, and economic drivers within the LMVJV could help inform our understanding and application of programs focused on tillage. Identifying cultural and/or economic motivations and impediments to enrolling in conservation programs or in different tillage practices likely would be helpful.

2) Environmental Goods and Services – It is not clear how best to incorporate this into our planning. There are two potential avenues to explore as relate to Ecological Good and Services (EGS): 1) Non-market value: other services that waterfowl habitat provides; and 2) economic impact assessments: revenue from waterfowl hunting, recreation, etc. Partners also identified a need to establish common terminology when discussing EGS. For resolution of these issues, the LMVJV's best course of action will be to follow Ducks Unlimited's lead through a working group tasked with better understand how EGS (water, carbon, nutrient retention, flood abatement, etc.) can be utilized within our geography to enhance conservation of key habitats.

3) Management Symposium – Bringing the issues and key people together to arrive at better mutual understanding of the challenges and common approaches to solving them is seen as an important Human Dimensions action for the LMVJV. Hence, the time is right for a symposium on state of waterfowl knowledge and management in the LMVJV. This is envisioned as a manager-oriented meeting with presentations as well as field excursion(s). Besides traditional waterfowl management, it would be beneficial to expose managers to social science/people objectives, the shifting constituency of conservation, and principles of conflict resolution and collaboration.

People: Issues and Challenges

- Lack of social scientists and social science expertise/support (at all levels)
- Ability to find a meaningful nexus between stated NAWMP people objectives (hunter numbers, conservation funding support) and habitat work occurring on the ground
- We are interested in using the Regional Planning Tool (Krainyk) to explore its potential usefulness with our partners. However, the tool is not available at this time.

How has thinking evolved/been influenced by Update(s)?

- Our revised population and habitat objectives will reflect the newest updated population estimates from Fleming et al. 2019
- We are attempting to address human dimensions questions/objectives, to the degree that we are able to access appropriate expertise, and it remains a high priority in our Operational Plan
- We will be convening a Human Dimenions Working Group that will help identify Human Dimension needs for various bird taxa, including waterfowl, and related projects

Please share any examples of integration attempts (between any of the three objectives)

- None yet

How has your JV approached adaptive management?

- The LMVJV has a long history of approaching adaptive management through Strategic Habitat Conservation. One of our best examples is through our landbird and forested wetland conservation efforts wherein we set population and habitat objectives, developed decision support tools and management guidelines that impacted conservation delivery, and then evaluated the effectiveness of forestry and management. We revised and adjusted our goals based on evaluation and new information. This full cycle of Strategic Habitat Conservation took over a decade to complete, but was accomplished successfully.
- In our 2015 waterfowl habitat stepdown document, we outlined potential management strategies (acquisition, restoration, and enhancement) to address aspirational goals and associated energy gains or losses. For example, based on the average acres of a crop type on private land, we calculated the DED trade-off of converting the equivalent acres of harvested soybeans to moist-soil wetland. These scenarios were intended to provoke thought regarding a portfolio of various management actions and subsequent tradeoffs.
- We are revisiting and revising our biological objectives for waterfowl and determining how best to measure available habitat with updated information in an adaptive framework. We will be incorporating new waterfowl population objectives (Fleming et al. 2019) and setting revised habitat objectives accordingly. Based on partner feedback, we completely revised our Water Management Unit database to include various levels of moist-soil management intensity, the ability to put more than one habitat type in an impoundment, and a shorebird habitat option. We use an average of public lands data across years to better reflect the variability in habitat provision. We have done an extensive literature review of current research to improve seed and invertebrate yield estimates of bottomland hardwood forest, cropland, and moist-soil.

III. Achieving Objectives - Conservation Actions

What has the JV done in relation to, and in the context of, achieving NAWMP objectives?

GOAL 1: *Abundant and resilient waterfowl population to support hunting and other uses without imperiling habitat.*

• The LMVJV partnership addresses the needs of non-breeding waterfowl. As such, our ultimate goal is to ensure that birds return to the breeding grounds in sufficient body condition to reproduce successfully. Thus, our primary emphasis is on addressing Goal 2 and ensuring that we have sufficient waterfowl habitat to meet waterfowl energy needs.

GOAL 2: *Wetlands and related habitats sufficient to sustain waterfowl populations at desired levels, while providing places to recreate and ecological services that benefit society.*

• The LMVJV partnership strives to provide high quality, non-breeding habitat for waterfowl. Partners consistently apply for and receive North American Wetlands Conservation Act grants to increase and improve the wetland management infrastructure necessary for effective management, and protect important wetland habitats. Our partners are actively working with agricultural producers to provide shallow water habitats in fall and winter. Finally, LMVJV partners continue to harness tens of millions of dollars annually to restore and manage bottomland hardwood habitat through Farm Bill Programs (e.g., WRE) and other sources.

GOAL 3: *Growing numbers of waterfowl hunters, other conservationists and citizens who enjoy and actively support waterfowl and wetlands conservation.*

- The LMVJV partnership has discussed addressing human dimensions in our geography. Hunter number has not been identified as a priority issue through our partnership. Instead, our focus is on private landowners and how we can best address barriers to their application of effective conservation practices.

Has effort shifted over time?

- Our partnership's mission to provide high quality habitat for non-breeding waterfowl has remained steady through time. LMVJV staff continue to provide support in terms of biological planning and conservation design, as well as delivery coordination and communication. LMVJV partners have always strived to deliver wetland habitat to meet NAWMP objectives.

AREAS OF NEED/ATTENTION

The LMVJV accepts responsibility for achieving national and international bird conservation objectives across five major bird guilds, and two Bird Conservation Regions, in the face of an increasingly complex set of environmental, economic, and social issues. As a result, we are challenged to adequately understand and address several important drivers of landscape change, as a partnership, due to lack of capacity for coordination and information synthesis. These drivers have a profound, but poorly understood, impact on bird habitat quantity and quality, and on the partners' ability to carry out appropriate conservation measures. The four areas of need are Avian Science, Climate Science, Hydrological Science, and Social Science.

Avian Science -- The foundation of our partnership is bird habitat conservation. The LMVJV Mission speaks to developing, implementing, and refining a shared vision of bird conservation. Priority actions in pursuit of this mission dovetail well with numerous other important conservation goals (e.g., climate adaptation, water conservation, social benefits, etc.). However, to understand, quantify, and effectively deliver on these areas of true nexus, our Bird Science must be solid, complete, and current. Ensuring that the LMVJV's foundational science for bird conservation is optimally developed and kept current (relevant) requires effective science coordination across each sub-discipline of waterfowl, songbird, shorebird, waterbird, and bobwhite ecology and management, and across two Bird Conservation Regions, with an understanding and sensitivity to their nexus with the other disciplines, and ample time to do the job well.

As with all aspects of science important to LMVJV priorities and objectives, the majority of work is accomplished through partnership, by partners. However, a key ingredient in that recipe for the LMVJV over the past three decades has been provision of dedicated JV Support Office Staff capacity to plan, organize, communicate, coordinate, and facilitate action by our partner staff in developing products (decision support tools, conservation plans, communications tools, etc.) appropriate to support the effective delivery of action in pursuit of the mission. Placing responsibility on a single individual (Science Coordinator) to remain current in the science, networking with other scientists, initiating and completing contemporary plans/tools/objectives, and publishing these results across all bird guilds and taxa in an efficient and effective manner is unrealistic. Splitting the primary Avian Science coordination responsibilities among two JV Support Office Science Staff is necessary, if timely and effective progress is to be made and maintained over time.

Climate Science -- Climate, soil, and disturbance are the ultimate drivers of ecological community composition and function. Hence, changes in climate impose significant impacts on habitat.

Importantly, confidence in the predicted trajectory of important climatological changes within a given geography is essential if conservation actions are to be tailored to fit and/or dampen that trajectory. Within the LMVJV geography, the choice of which model(s) is applied can have a significant effect on not only the severity of forecasted impacts, but even the direction of the trajectory of some variables. For this reason, informing and/or adjusting LMVJV bird population and habitat objectives using climate change predictions has been, and continues to be, problematic.

However, the current political and funding environment increasingly places a premium on the ability to express goals, objectives, and expected outcomes in terms of climate-related benefits and accommodations. The LMVJV's standing in this regard (political support, financial support, etc.) will be improved in direct proportion to our ability to demonstrate a nexus with and communicate our priorities and actions in connection to climate change. Using recent, accepted, published work, the LMVJV can begin by cataloguing plausible climate-positive equivalents (e.g., sequestration rates, connectivity, etc.) for our most prevalent priority actions (reforestation, wetland restoration, forest management). Beyond this, if the partnership's decision support tools are to be informed by climate science, partner consensus on the most plausible climate change models (or suite of models) and parameters will be necessary. Outputs from these predictive models can then be used to inform the relevant features of our habitat models.

As with all others aspects of science important to LMVJV priorities and objectives, the majority of work will be accomplished through partnership, by partners. Close association of the Migratory Bird and Science Applications Programs in USFWS, Interior Regions 2 & 4 likely can facilitate the LMVJV's access to significant technical capacity regarding climate change and related model application. Some cursory "equivalents" are easily obtained from the literature (e.g., carbon sequestration rates for afforestation in the MAV). However, a more thorough (and dynamic) synthesis of existing literature, practices, etc. will require focused attention and investment of time. Pursuing questions of climate change, its nexus with LMVJV priorities, and specifically applying these to our habitat objectives, priorities, and models in a timely and effective manner will require at least some degree of additional dedicated science coordination capacity.

<u>Hydrological Science</u> -- Terrestrial conservation issues connected to water are significant and numerous within our geography. While not exclusive to lowlands, the most pervasive and easily-understandable water issues relate to impacts upon bottomland hardwood habitat – both in the MAV and WGCPO. From reservoir development to prolonged flooding to drying of once-wet surface and subsurface layers, the LMVJV's collective understanding of the ecological and sociological drivers, consequences, and possible solutions to changed/changing hydrological patterns will greatly impact our ability to conserve these systems for birds. Making useful progress in this arena will require a comprehensive synthesis of what is already known, coupled with a short list of priority actions necessary to fill in critical knowledge gaps, then working to fill the gaps. This synthesis, identification, and closing of gaps applies equally to the science and policy of water (surface and subsurface).

As with all others aspects of science important to LMVJV priorities and objectives, the majority of work will be accomplished through partnership, by partners. However, doing this in an effective and efficient manner will require additional science/information coordination capacity, no different from the way we address bird biology and delivery questions. Preliminary effort (2016 SEAFWA) was initiated to begin scoping issues relevant to floodplain hydrological challenges. Whereas investigations into these issues have continued throughout the LMVJV geography and beyond by scientists (USGS, LSU, etc., etc.), no concerted effort has been applied to a useful synthesis and focused effort(s) by the LMVJV. Pursuing an actionable, broad-scale understanding of floodplain hydrology (science, and informing policy) as a partnership will require additional dedicated science and information coordination capacity.

Social Science -- Human behavior/attitude factors strongly influence conservation success. Understanding the primary drivers of decision-making surrounding important conservation actions is the first step to increasing our reach and effectiveness. We must work as partners to identify the most important (assumed) limiting factors in understanding and applying solutions to attitudinal/behavioral hurdles to achieving LMVJV objectives. Following this, we must then secure appropriate resources for addressing the questions, then practically apply this new/refined understanding to delivery.

As with all others aspects of science important to LMVJV priorities and objectives, the majority of work will be accomplished through partnership, by partners. However, doing this in an effective and efficient manner will require some level of additional science coordination capacity. A preliminary effort was begun (Nov 2019) with respect to scoping priority human dimensions issues that impact achieving our waterfowl objectives. Revision of the LMVJV waterfowl energetics model and objectives in 2022 will utilize application of social science. In a similar way, partners have begun applying basic social science theory, principles, and approaches to better understanding landowner adoption of important practices within Open Pine ecosystems in Arkansas and Louisiana (Morehouse Family Forest Initiative), with expanded effort planned outside the 8 MFFI counties/parishes in 2022 through RCPP. The 2018 Organizational Plan priority of piloting an effort to use existing public land-use information (monitoring data) to synthesize, analyze, and understand numerical response of humans to management actions on appropriate state Wildlife Management Areas has not yet begun. Pursuing social science questions in a timely and effective manner will require at least some additional dedicated science coordination capacity.

IV. Additional Insights

Recommended "Best Practices" that might transfer to other JVs

- Thoroughly vet population and habitat objectives within the partnership
- Consistency (or at least complementarity) in setting population objectives across Joint Ventures that share common partners is ideal
- Continue sharing of information, modeling approaches, and constructive feedback through shared forums such as the Unified Science Team and the NAWMP Science Support Team.

Areas your JV is struggling with, perhaps where more guidance/technical support would be of value

- More social science capacity in the Joint Venture community is needed to support NAWMP social science expectations.
- We are very interested in using the Regional Planning Tool to explore its potential usefulness with respect to social inputs. However, the tool is not available.

V. Progress in Relation to Previous PC Recommendations

Following is a summary of critique/recommendations extracted from the 15 March 2017 Plan Committee letter to the LMVJV Management Board. Each bulleted subject will be addressed in turn.

1. Light coverage of adaptive management adjustments
2. Assessment of spring waterfowl migration habitat requirements
3. Assess climate change impacts on waterfowl distributions

4. More information about the state of the JV partnership
5. Integration of “all bird” priorities at the CDN scale
6. Address annual variation in habitat in the planning process

Adaptive Management Adjustments -- Adaptive adjustments in LMVJV waterfowl habitat conservation have and continue to come primarily in the form of (a) improved understanding of food energy provision by various management/habitat categories, (b) increased ability to remotely estimate food energy available in naturally-flooded habitats, (c) a refined method of tracking public managed habitat, and (d) from updated continental population objectives stepped down to our BCRs.

Spring Waterfowl Migration Habitat Requirements -- No progress has been made in assessing spring migration habitat. However, our new modeling approach may allow for some estimation of this.

Assess Climate Change Impacts on Waterfowl Distributions -- Several studies utilizing empirical data [e.g., Thurber et al 2020, Meehan et al 2021] and climate models [e.g., Notaro et al 2016, Lange et al 2018, O’Neal et al 2018] to understand/predict waterfowl distribution relative to climate change have been recently published. Predicted increases in average winter temperature and decreased snow accumulation at latitudes north of the LMVJV suggest northward distributional shifts, and empirical data are consistent with such a northward shift. This pattern, on it’s own, results in lower non-breeding duck population numbers within the LMVJV region. At the same time, predicted negative impacts of sea level rise on Gulf Coastal Plain shallow wetland habitats may suggest a northward shift in non-breeding duck distribution from the Gulf Coast into the LMVJV. A clearer understanding of net effects of climate change, as well as increased confidence in model predictions, will be necessary before making changes to regional population and habitat objectives. Several attempts to obtain research funding through partner academic institutions for exploring LMVJV-specific climate impacts on waterfowl distribution have so far been unsuccessful.

State of the LMVJV Partnership -- The example stated in the 2017 PC letter refers to the LMVJV’s need to manage Conservation Delivery Networks (CDNs) to ensure that overall JV objectives are achieved, with a suggestion to monitor individual CDN contributions. Our CDNs continue to be active, dynamic networks of local/regional partners strategically pursuing multiple bird (and related natural resource) conservation objectives within their sub geographies. Each CDN is staffed by one of the LMVJV’s Partnership Coordinators, prioritizes actions using significant input from the LMVJV’s bird planning priorities, and provides reports and updates to the LMVJV Management Board twice annually.

Integrating “all bird” Priorities at the CDN Scale -- Integration of spatial priorities among multiple bird guilds will be possible only as such priorities are developed for guilds other than forest breeding songbirds. It is anticipated that spatial priorities (at a finer scale than State/BCR) for waterfowl habitat conservation will be a product of the upcoming (2022) revision process. Further, spatial priorities for secretive marsh bird habitat is anticipated be a product of that (ongoing) planning effort.

The LMVJV has and continues to facilitate integration of wetland-dependent bird habitat conservation through provision of information and delivery of shallow wetland habitat management workshops (2015, 2021/22). The most recent online workshop (Aug/Sep 2021) explicitly addressed multi-guild management opportunities and tradeoffs at the area/site scale.

Addressing Annual Variation in Habitat in the Planning Process -- Annual variation in habitat conditions is addressed within the LMVJV’s waterfowl habitat objective-setting process in at least three ways. First, our assessment of naturally flooded and private lands habitat – a significant portion of assumed available food energy – is derived using DED values reached or exceeded in 4 of 5 years (80% of winters), estimated using Monte Carlo simulation. This approach is used in acknowledgement that habitat conditions are temporally variable within the LMVJV. Second, our assessment of public lands habitat (energy) provision is based upon a three-year average, so as to account for annual variability driven mainly by weather (but also by capacity). Finally, we are developing habitat goals with the continental 80th percentile population objectives driving our operational objective, and habitat provision below that which is required to support the Long-term Average population objective as a "critical red flag" that, if not consistently exceeded would trigger concerted actions to accelerate conservation efforts.

SUMMARY OF BREEDING HABITAT CHARACTERISTICS FOR THE LOUISIANA WATERTHRUSH (*PARKESIA MOTACILLA*)

Lower Mississippi Valley Joint Venture
Janine Antalffy – *Directorate Fellow, USFWS*
Keith McKnight – *Coordinator*
Anne Mini – *Science Coordinator*
Blaine Elliot – *GIS Applications Biologist*

Background

The Louisiana Waterthrush (*Parkesia motacilla*), is a neotropical migratory songbird that breeds throughout the central and eastern United States, from Texas and Georgia up through Minnesota, Ontario, and central New England (Prosser & Brooks, 1998). Geographically positioned towards the southwestern periphery of the Louisiana Waterthrush's (LOWA) breeding range, the West Gulf Coastal Plain and Ouchitas bird conservation region (WGCPO) supports roughly five percent of the LOWA breeding population. While not considered a species of concern at the continental scale, within the WGCPO data from the Breeding Bird Survey suggest an overall decline in LOWA detections since 1966 (Sauer et al. 2014). As an interior forest species dependent on high-quality headwater streams, the LOWA is particularly vulnerable to land use changes that characterize the WGCPO region, such as conversion of forest for shale gas development, silviculture, and agriculture. This type of anthropogenic activity not only decreases the availability of large, contiguous tracts of forest but also may alter hydrologic characteristics and functions having potential impacts on the quality of LOWA breeding habitat. With a foraging strategy that is largely dependent on pollution-sensitive aquatic macroinvertebrates, the LOWA is subsequently vulnerable to environmental factors affecting the availability of this resource. As such, the LOWA is an important indicator of stream quality and overall riparian ecosystem health.

Given the documented decline within the WGCPO region, along with its utility as a bioindicator of riparian ecosystem health, the LOWA is considered a conservation priority by the Lower Mississippi Valley Joint Venture (LMVJV). At the forefront of conservation planning and management is the prioritization of areas of optimal breeding habitat that may be critical to sustaining long-term viable populations. The ability to successfully target optimal LOWA breeding habitat requires an understanding of the key habitat features that influence reproductive success. Some habitat associations for the LOWA have been well known for decades, such as the dependence on first and second order headwater streams and large patches of contiguous forest (Bent 1963, S. C. Robbins et al. 1989, Hamel 1992). Over the last two decades, however, researchers have begun to look more closely at the relationship between LOWA reproductive success and both fine-scale habitat features and adjacent land use activity. Most of this research was conducted at a local scale in a few states including Pennsylvania (Mattsson and Cooper 2007, Mulvihill et al. 2008, 2009, Mattsson et al. 2011), West Virginia (Wood et al. 2016, Frantz et al. 2018*b*), Missouri (Peak et al. 2006) Minnesota (Stucker and Cuthbert 2000), Arkansas (Marshall 2012, Latta et al. 2015), Tennessee (Bryant et al. 2020), and others. With the exception of Tirpak et al. (2009), there is little literature pertaining to LOWA breeding habitat associations within the WGCPO region. Regardless, the existing body of research regarding this important component of natural history provides crucial information that can be incorporated into management strategies despite the lack of region-specific research.

The following is a synthesis of scientific research, reviews, and literature relating to the LOWA breeding habitat features that are key to sustaining long-term, viable populations. A literature search conducted on Google Scholar using the search terms "Louisiana Waterthrush" and "breeding habitat" yielded 501 results (excluding citations). The first 100 most relevant results were visually scanned to filter out articles that did not include the LOWA in a study relating to or tangentially relating to any breeding habitat feature. Duplicate articles and conference publications were also excluded. The application of filter criteria resulted in 51 results relevant to breeding habitat features for the LOWA. The following pages contain a summary of the key breeding habitat features extracted from this body of literature.

SUMMARY OF KEY BREEDING HABITAT CHARACTERISTICS

Key breeding habitat characteristics of the LOWA are categorized as components of either overall vegetative cover (e.g., percent canopy cover) and/or foraging habitat (e.g., stream substrate).

COVER

Forest area

At the landscape scale, one of the most critical breeding habitat features is forest area or patch size. Perhaps the first real systematic study quantifying optimal forest patch size for the LOWA was conducted by Robbins et al. (1989) in Maryland and the adjacent Mid-Atlantic region. In this study, researchers identified forest area as a significant predictor of LOWA relative abundance, showing that maximum probability of occurrence was associated with forest patches greater than 3,000 hectares (ha). Probability of occurrence was at 50% for forest patches as small as 350 ha, although, LOWA were detected at least twice in forest patches ranging from 24.7 ha to 184 ha (Robbins et al. 1989). Prosser and Brooks (1998) and Tirpak et al. (2009) referenced this study in their validated Habitat Suitability Index (HSI) models for the LOWA, where Suitability Index (SI) values for forest patch size included 0 (patches under 42.2 ha from Hayden et al. 1985), 0.5 (patches between 350 and 3,200 ha), and 1.0 (patches greater than 3,200 ha). These estimates of optimal forest area for the LOWA are accepted by the research community and have been frequently reinforced in the literature. For instance, Conner and Dickson (1997), examined the general relationship of the LOWA and forest fragmentation, patch size, edge effects and land use patterns. Based on the work from Robbins et al. (1989), Conner and Dickson suggested that LOWA only become moderately abundant (probability of occurrence = 0.2) in forest patches over 1,000 ha in the WGCPO (Conner and Dickson 1997). In their report on management objectives for breeding birds in the Mississippi Alluvial Valley

(MAV), Mueller et al. (1995) calculated that an area of 7,200 ha is required to support 500 breeding pairs of LOWA.

The relationship of riparian buffer width and LOWA occupancy has received a fair amount of attention in the literature, particularly given that LOWA is a stream-obligate species. Peak and Thompson (2006) investigated LOWA densities in riparian forest patches ranging from narrow (55 to 95 meters) to wide (400 to 530 meters) and found significantly higher densities in riparian forest patches classified as wide. Similarly, Mason et al. (2007) only detected LOWA in forested “greenways” greater than 300 meters wide in North Carolina, further highlighting this species’ dependence on large tracts of forest.

There are a few examples in the literature, however, that provide some evidence to suggest that LOWA may have a wider niche breadth with regards to forest area requirements. For instance, in a report establishing resource priorities for the Silvio O. Conte National Fish and Wildlife Refuge (Massachusetts), Thompson (n.d.) suggested that LOWA require a minimum of 250 acres (101 ha) of contiguous forested area, which is smaller than previously mentioned estimates of minimum area requirements. Furthermore, in a study conducted by the U.S. Department of Defense, Nott et al. (2003) found that, while LOWA were associated with areas consisting of 50 – 90% forest cover, population trends decreased with increasing total forest cover. This finding, coupled with the positive relationship found with LOWA abundance and the total amount of forest edge, suggests that this species may tolerate some degree of fragmentation, although this threshold was not identified in this study (Nott et al. 2003).

Interestingly, in a study comparing avian abundance in bottomland-hardwood forest stands of varying widths in South Carolina, Kilgo et al., (2018) found that LOWA had the highest probability of detection in stands less than 25 meters wide. In Indiana, Chapman et al. (2015) detected a higher proportion of LOWA within avian communities within medium-width riparian buffers (26-75 meters, “m”) than those over 75 m. It is crucial to note, however, that none of these examples considered breeding success, and therefore do not provide evidence that these smaller patches and narrow riparian buffers provide suitable LOWA breeding habitat.

Forest overstory structure and composition

Many studies address, to some degree, the preference of the LOWA for a particular forest type. One early study investigating habitat relationships of warblers in North Carolina showed that LOWA selected both beech forest and floodplain forest (Parnell 1969), over pine forest, oak-hickory forest, and mixed pine-hardwood forests. Later, using data from the Breeding Bird Survey (BBS), Hamel (1992) found that, in the Southeast region of the United States, the LOWA was most often associated with mature woody wetlands (i.e., oak-gum-cypress bottomland forests; average of five detections per survey). In Ohio, LOWA were frequently associated with study plots characterized as floodplain (Means and Medley 2010). In the Midwest region, however, researchers found a higher relative abundance of LOWA in upland forests dominated by oak-hickory (relative abundance = 0.56) than in floodplain forests of two major types including elm-ash-cottonwood and oak-gum-cypress (relative abundance = 0.38) (Knutson et al. 1995). LOWA were absent altogether from floodplains during a case study in Minnesota and Wisconsin (Knutson et al. 1995). Researchers suggest that a potential explanation for the absence of LOWA in floodplain forests in this region could be that water levels vary greatly, frequently flooding the ground substrate and compromising nest survival rates (Knutson et al. 1995). Skinner (2003) reports LOWA breeding in both upland and floodplain habitats in Ohio. Twedt et al. (2010) report a negative association with LOWA abundance and the proportion of hardwood forest with bottomland hardwood species in a study assessing the relationship between avian abundance and forest condition derived from the Forest Inventory Analysis (FIA) throughout the southeast. Most of the literature pertaining to the LOWA in the southeast, however, supports a preference for, or at least presence in, bottomland hardwood forests (Parnell 1969, Hamel 1992, Mueller et al. 1995).

Evidence in the literature also supports a strong preference for either deciduous, coniferous, or mixed forest habitat in other parts of the LOWA breeding range. In the Central Appalachians, Murray and Stauffer (1995) investigated non-game bird habitat use and found that LOWA were more abundant in riparian areas dominated by deciduous species than those dominated by coniferous hemlock. In their 1998 HSI model, Prosser and Brooks defined optimal forest composition for LOWA breeding habitat in the Mid-Atlantic as mixed deciduous / coniferous forests (Prosser and Brooks 1998). This HSI characterized optimal forest breeding habitat as large forest patches consisting of 30-69% deciduous species, with the coniferous species making up the remaining percentage (SI = 1.0). Forests characterized as mostly coniferous (0-29% deciduous) or mostly deciduous (70-100% deciduous) were each assigned an SI value of 0.5 (Prosser and Brooks 1998). Based on Hamel (1992), Tirpak et al. (2009) modified these SI values pertaining to forest composition in the Southeast region, specifically the WGCPO. Tirpak et al. (2009) combined landform (floodplain-valley, terrace-mesic, and xeric-ridge), landcover type (low-density residential, transitional-shrubland, deciduous forest, evergreen forest, orchard-vineyard, and woody wetlands) and successional age class (grass-forb, shrub-seedling, sapling, pole, and saw timber) to assign SI values to LOWA breeding habitat in the WGCPO. In contrast to Prosser and Brooks (1998) this HSI suggested deciduous and woody wetlands (mature sawtimber) represented optimal LOWA breeding habitat in the WGCPO within floodplain-valley and terrace-mesic landforms (SI = 1.0). Suitability decreased, however, for deciduous and woody wetland stands in both floodplain-valley and terrace-mesic landforms as stand maturity decreased (i.e., pole timber stands; SI = 0.5). Maximum SI for mixed forest in both floodplain-valley and terrace-mesic landforms within the WGCPO region was only 0.33 (mature, saw timber). Maximum suitability within the xeric-ridge landform was represented by late-successional (saw timber) woody wetlands (SI = 0.667) and deciduous forest (SI = 0.5). Low quality or suboptimal habitats included mixed, pole timber stands in floodplain-valley and terrace mesic landforms (SI = 0.167), deciduous, pole timber stands in xeric-ridge (SI = 0.25), woody wetland, pole timber stands in xeric ridge (SI = 0.334), and mixed, pole timber stands in xeric-ridge (SI = 0.167). Suitability of forest habitats characterized as early succession (i.e., grass-forb, shrub-seedling, and sapling) was equal to zero for all landforms and landcover types (Tirpak et al. 2009).

In a more recent study assessing the performance of landscape capability models, Loman et al. (2018) found that most LOWA point-count occurrences were in northern hardwood-conifer and central oak-pine forest types across the northeastern United States.

The variation in LOWA forest type preferences reported in the previous studies may be an artifact of geographic variation in habitat availability and quality. With regards to the WGCPO, however, most studies suggest a preference for deciduous bottomland and floodplain forest and woody wetlands (Parnell 1969, Hamel 1992, Mueller et al. 1999, Tirpak 2009).

Canopy cover

Many studies and references exist in the literature that associate optimal LOWA breeding habitat with a heavily forested, closed-canopy landscape (Schulz et al. 1992, Prosser and Brooks 1998, Nott et al. 2003, Peak and Thompson 2006, Tirpak et al. 2009, Latta 2009, Marshall 2012, McClure and Hill 2012, etc.). The Prosser and Brooks 1998 HSI characterized optimal percent canopy cover for LOWA breeding habitat as greater than 80% (SI = 1.0), followed by 60-80% (SI = 0.7). Sub-optimal habitats were characterized by 40-59% canopy cover (SI = 0.2). LOWA were not associated with forest patches with less than 40% canopy cover (SI = 0). In a 2002 study conducted in the Georgia Piedmont region, researchers found a negative correlation with LOWA abundance and percent canopy cover, although the relationship was not significant (Hyder 2002). In northeastern Missouri, Peak and Thompson (2006) found that LOWA densities were highest in forest areas characterized by a dense canopy (88.04% canopy cover). Tirpak et al. (2009) modified Prosser and Brooks SI scores for canopy cover in their HSI for the WGCPO, restricting maximum optimality (SI = 1.0) to forest areas with greater than 90% canopy cover (60-89%, SI = 0.7; 40-59%, SI = 0.2, < 40%, SI = 0).

There are several studies linking canopy cover with habitat quality and nesting success. Canopy cover was positively correlated with LOWA nesting success (as measured by successfully fledged fledglings) in a 2009 study conducted in western Pennsylvania (Latta 2009). In the Buffalo National River watershed of northern Arkansas, researchers found a significant inverse relationship between canopy cover and LOWA linear territory length (Marshall 2012). Given that LOWA territory size has been shown to increase with decreasing habitat quality (Mulvihill et al. 2008, Mattsson and Cooper 2009), the relationship found by Marshall (2012) effectively suggests a positive relationship between canopy cover and habitat suitability.

Other studies provide further evidence that the LOWA require a closed canopy forest structure, even though they did not measure nesting success directly. For instance, in a study investigating the effects of herbicides on breeding birds in central Oklahoma, researchers found that LOWA had significantly higher densities on closed-canopy control sites relative to treatment plots (Schulz et al. 1992). McClure and Hill (2012) found that LOWA were significantly more likely to colonize areas with high canopy cover in Alabama, although no percentages were reported. In a study investigating the relationship between reproductive rate and minimum area breeding requirements in central and eastern United States, researchers estimated that the LOWA required a minimum of 99% forest cover to reach 50% probability of presence (Vance et al. 2003). It is important to note, however, that this study relied on BBS data, and therefore LOWA may have had lower detection rates, given their close association with riparian habitats.

As part of a greater study assessing the relationship between avian demographic trends and landscape patterns on Department of Defense (DoD) installations, Nott et al. (2003) showed that LOWA were associated with areas characterized by 50-90% forest cover. Interestingly, however, this study showed a negative association with adult LOWA abundance and percent forest cover and a positive association with total amount of agricultural edge. Despite the findings reported in Nott et al. (2003), the literature reliably supports a preference of the LOWA for closed canopy, heavily forested landscape.

Successional stage

There are several examples in the literature associating LOWA with the successional stage of the forest. In a 1979 study investigating the effects of silviculture on the forest bird community in Virginia's pine-oak forests, Conner et al. only detected LOWA in mature forest stands over 30 years old. Likewise, LOWA were absent from stands characterized by saplings and pole-timber in both oak-hickory and Loblolly-shortleaf pine forests, and only associated with mature stands greater than 60 years old in central and southeastern forests (Dickson et al. 1992). Skinner, in a breeding bird survey in 2003 in Ohio, found LOWA were only present in forest stands classified as mature. A 2011 study in Ohio assessing habitat composition and structure found a positive correlation with LOWA detections and canopy height, suggesting a preference for mature forest (Pennington and Blair 2011). To our knowledge there are no studies contradicting the LOWA's dependence on old-growth and mature forest stands.

Riparian vegetative structure and understory composition

At a smaller scale, vegetation characteristics of the immediate riparian habitat may be crucial to LOWA breeding success, although there are only a few studies that directly address this relationship. Prosser and Brooks (1998) assigned maximum HSI scores to riparian habitats characterized by understory shrub cover over 1.5 meters in height in moderate densities (SI = 1), followed by sparsely distributed shrub cover over 1.5 meters (SI = 0.8). Habitats with dense shrub cover over 1.5 meters (SI = 0.4), as well as shrub cover less than 1.5 meters high at high, moderate, and sparse densities (SI = 0.1, 0.3, and 0.5, respectively) represent sub-optimal habitat. Regarding herbaceous cover, habitat suitability was dependent on height and density of herbaceous cover, where most suitable habitat was associated with moderate to sparsely distributed low cover (< 5 cm; SI = 1). However, optimal suitability was also associated with sparsely distributed, tall (> 20 cm; SI =1) herbaceous cover. Areas characterized by low, but densely distributed herbaceous cover received an SI of 0.7, suggesting high suitability as did areas where herbaceous cover ranged from 5 – 20 cm and was present in moderate densities. A sub-optimal SI of 0.3 was assigned to areas with tall herbaceous cover present in moderate densities as well as dense cover ranging from 5 – 20 cm in height. Dense herbaceous cover over 20 cm high resulted in unsuitable breeding habitat (SI = 0). Findings from Schulz et al. (1992) also suggested that the LOWA was associated with forest areas containing lower proportions of herbaceous ground cover, although this study was not restricted to riparian zones, but rather characterized whole forest stands.

One study conducted in the Great Smokey Mountains in the southern Appalachians linked breeding success, as measured by daily survival rate (DSR), with understory composition (Bryant et al. 2020). In this study, DSR decreased with the proportion of deciduous understory, suggesting higher DSR in habitats with an understory dominated by conifers. Collectively, there appears to be a lack of empirical studies linking breeding success to surrounding understory woody and herbaceous cover and more work is necessary to fully understand how the immediate riparian understory impacts LOWA nesting success across the entirety of its range.

Foraging and Nesting Habitat

Stream morphology and in-stream habitat

The association of LOWA with headwater streams, first order (small streams with no tributaries) and second order (small streams fed by only one tributary) is well established in the literature (Eaton 1958, Thompson 1996, Mulvihill et al. 2009, Prosser and Brooks 2011, Frantz et al. 2018*b*). In addition to stream order, stream regime is an important factor associated with LOWA presence and breeding success, as demonstrated by Latta (2009) who found a significant positive relationship between unsuccessful nests and the proportion of intermittent streams, highlighting LOWA dependence on perennial streams (Latta 2009).

Stream morphology was also shown to influence LOWA density, productivity, and nest survivorship (Barnes et al. 2018). In this study focusing on hemlock dominated streams in northern Pennsylvania, researchers found that LOWA had higher densities and breeding success in bench streams (e.g., braided streams flowing throughout a fairly wide, flat floodplain) when compared to ravines (e.g., fast flowing, high gradient streams with steep, V-shaped banks) (Barnes et al. 2018). The authors propose that predation rates may have been higher in ravines, therefore rendering these habitats less suitable for LOWA breeding.

In-stream habitat is also influential to LOWA presence and breeding success, including stream microtopography, stream substrate, and proportion of exposed rock (Prosser and Brooks 1998, Stucker and Cuthbert 2000, Hyder 2002, Latta 2009, Mattsson and Cooper 2009, Barnes et al. 2018). Prosser and Brooks (1998) suggested maximum suitability for first and second order streams with riffles (i.e., shallow, fast moving parts of the stream with rocks breeching the surface) and pools (i.e., deep, slower moving parts of the stream; SI = 1). Streams of first and second order with a higher topographic gradient and faster moving water over riffles were still largely suitable (SI = 0.7). Habitat suitability decreases with 3rd order streams, although the presence of riffles can provide sub-optimal habitat (SI = 0.5). Third order streams consisting of mostly runs provide poor habitat for LOWA (SI = 0.2).

A 2000 study in Minnesota found that there was a significantly higher proportion of riffles on streams occupied by LOWA (Stucker and Cuthbert 2000). This study found that stream reaches occupied by LOWA have, on average, roughly 40% riffle versus 20% in unoccupied reaches. Another study conducted in Georgia found a positive, yet non-significant association of LOWA presence with increasing percent riffle (Hyder 2002). Along with the presence of riffles, the amount of exposed rock within a particular stream reach is important to LOWA foraging. In a Minnesota study aimed at understanding LOWA reproductive success and breeding habitat characteristics, percent of exposed rock in LOWA-occupied reaches was, on average, roughly 15% versus 7% in unoccupied stream reaches (Stucker 2000). Bryant et al. (2020) more recently found that percent of exposed in-stream rock was the top predictor for LOWA forage habitat selection, along with exposed woody debris.

In addition to stream order, percent riffle and exposed rock, stream substrate and clarity are critical to LOWA foraging. Prosser and Brooks (1998) showed that optimal habitat consisted of a coarse or sandy stream substrate and high clarity (SI = 1). Stream reaches characterized as clear with fine substrate or turbid with coarse or sandy substrate were suboptimal (SI = 0.5). LOWA were very unlikely to be found breeding along turbid stream reaches with fine substrate (SI = 0, Prosser and Brooks 2011).

The literature collectively and consistently shows that LOWA require healthy first or second order headwater streams with a moderate to high proportion of riffles and exposed rock.

Proximity to anthropogenic disturbance

Given that the LOWA is an area-sensitive, forest interior species, it is rarely associated with anthropogenic habitats. However, there is a substantial body of work investigating the impacts of human activity on LOWA habitat and breeding success (Hyder 2002, Mulvihill et al. 2008, Mattsson and Cooper 2009, Marshall 2012, Latta et al. 2015, Frantz et al. 2018*a*, 2019, Farwell et al. 2019).

In Georgia, Hyder (2002) found that LOWA were more abundant in large riparian buffers surrounded by non-hostile adjacent habitat (e.g., rotation loblolly pine forest) than in buffers surrounded by hostile adjacent habitats (e.g., clear-cuts). In another Georgia study, nestling survival was low when territories in wide riparian buffers (at least 160 meters) were within 1.75 km of agriculture (Mattsson and Cooper 2009).

Cowbird parasitism is generally higher in more fragmented forests as the amount of edge habitat adjacent to hostile habitats including clear-cuts and agriculture increases. Where cowbirds are present, researchers have shown a decrease LOWA fledging success (Stucker and Cuthbert, 2000), although there is research to suggest that rates of brood parasitism are low in LOWA, as this species is typically found within the forest interior (Robinson and Wilcove 1999). Lower LOWA productivity found in association with cowbird parasitism, however, has important implications as fragmentation continues to affect the landscape. Another study investigated the relationship of LOWA habitat quality and anthropogenic land use in northern Arkansas (Marshall 2012). When comparing protected and unprotected stream reaches, this study found that LOWA territories were larger on unprotected streams more heavily impacted by hostile adjacent habitats and land use (Marshall 2012). Territory size can be an important proxy for habitat quality, as LOWA territories have been shown to have an inverse relationship with both habitat quality and breeding productivity (Mulvihill et al. 2008, Mattsson and Cooper 2009, Frantz et al. 2018*b*). Marshall (2012) also showed that the proportion of pollutant intolerant macroinvertebrate taxa, an important food source for LOWA, decreased in unprotected, polluted streams.

Several studies highlight the detrimental effects of stream acidification associated with shale gas development on water quality, the benthic macroinvertebrate community, and, subsequently, LOWA habitat quality and breeding success (Mulvihill et al. 2008, Latta et al. 2015, Frantz et al. 2018*b*, 2019, 2020). Mulvihill et al. (2008) found higher rates of site fidelity on circumneutral (i.e., neutral pH) streams than streams with low pH in southwestern Pennsylvania, suggesting the circumneutral streams represent more suitable habitat. Similarly, Frantz et al. (2019) found that female LOWA had lower site fidelity and lower reproductive success in areas impacted by shale gas in West Virginia. In an earlier study, Frantz et al. found significantly lower DSR, and, ultimately, lower productivity, in LOWA territories impacted by shale gas runoff or falling within 60 m of shale gas development and associated infrastructure (Frantz et al. 2018*b*). This study also found LOWA were breeding in lower densities along stream reaches impacted by shale gas. Based on these findings, Frantz et al. (2018*b*) suggested that LOWA breeding along degraded streams impacted by shale gas development serve as “sink” populations due to lower nest survival and productivity. In addition to lower reproductive success, researchers have also found evidence of bioaccumulation of metals (specifically Barium and Strontium) and an associated epigenetic response in LOWA breeding along impacted streams in both Pennsylvania and Arkansas (Latta et al. 2015, Frantz et al. 2020). Although the latter study did not address breeding success, it does provide evidence of an interaction between contaminants associated with shale gas development and the riparian ecosystem. More evidence of a negative association with shale gas development and LOWA habitat suitability comes from Farwell et al. (2019) who found that LOWA abundance was negatively associated with shale gas development in West Virginia.

The evidence presented collectively in the literature suggest that LOWA may be sensitive to surrounding land use practices, and proximity to anthropogenic disturbance may influence the quality of breeding habitat by impacting water quality and food availability.

Prey availability and abundance

The availability of food resources for the LOWA is associated with several of the factors mentioned above. In-stream habitat (e.g., proportion of riffles), proportion of exposed rock, and stream substrate, for instance, facilitate LOWA foraging success. LOWA focus most of their foraging efforts on aquatic, benthic, macroinvertebrates in first and second order streams (Craig 1984). In a study comparing the foraging ecology of LOWA with the closely related Northern Waterthrush, Craig (1984) observed LOWA consuming isopods (e.g., aquatic pill bugs), gastropods (e.g., freshwater snails), nymphs of Ephemeroptera (mayflies), Trichoptera (caddisflies) larvae, Culicidae (mosquitos), and Dytiscidae (aquatic beetles).

Many studies that mention LOWA foraging ecology focus on invertebrates representing the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies; EPT taxa). EPT taxa are vulnerable to changes in stream water quality, and there is a substantial body of work supporting the association of LOWA presence and productivity with the abundance of EPT taxa (Stucker and Cuthbert 2000, Mattsson and Cooper 2006, Mulvihill et al. 2008, Trevelline et al. 2016, 2018, Frantz et al. 2018*a*, 2019). For instance, Stucker and Cuthbert (2000) found a higher proportion of EPT taxa in stream reaches occupied by breeding LOWA than those unoccupied. Mattsson and Cooper (2006) showed that LOWA occupancy was a useful indicator of the proportion of EPT taxa within a stream reach. When investigating the effects of stream-water acidification on the breeding ecology of LOWA, Mulvihill et al. (2008) found that there was a lower proportion of Ephemeroptera taxa in acidic versus circumneutral streams. Frantz et al. (2019) similarly found that EPT richness declined with shale gas activity, and that LOWA were observed to expand their foraging diet along degraded stream reaches. These findings, in addition to higher site fidelity on circumneutral streams, indicate that stream acidification and pollution decrease habitat suitability for the LOWA.

When looking at LOWA nestling diet, Trevelline et al. (2016) found that, while the relative abundance of EPT taxa was high across study sites in Pennsylvania and Arkansas, the three most common orders included terrestrial Lepidoptera (butterflies and moths), aquatic Diptera (flies), and Ephemeroptera. Later, in a study comparing nestling diets of LOWA, Acadian Flycatcher, and Wood Thrush, Trevelline et al. (2018) continued to find a high proportion of Lepidopterans. The prevalence of terrestrial Lepidopteran taxa highlights that, in addition to reliance on the aquatic invertebrate community, reproductive success may also rely on the terrestrial invertebrate community later in the breeding season. Plecoptera and Trichoptera were unique to LOWA nestling diet.

That both adults and nestlings are known to consume pollutant intolerant taxa supports the negative association with lower Louisiana Water abundance and productivity and stream degradation resulting from human activity, including shale gas development, mining, and agriculture.

Nesting habitat

Habitat features important for nesting include the slope and construct of the stream bank as well as surrounding ground characteristics (Prosser and Brooks, 1998, Stucker and Cuthbert 2000, Bryant et al. 2020). The 1998 HSI suggested that the presence of fallen trees within 50 meters of the stream was associated with optimally suitable nesting habitat (SI = 1.0), as LOWA typically construct their nests within the roots of upturned trees (Prosser and Brooks 2011). LOWA also build their nests in depressions along stream banks (Prosser and Brooks 1998). Stream banks consisting of a mix of soil, rocks, and tree roots provide crevices to facilitate nest building and provide optimal habitat (SI = 1.0 for bank slopes over 30°; SI = 0.7 for gentle bank slope less than 30°) (Prosser and Brooks 1998). Stream banks consisting of more than 75% rock or 70% herbaceous cover provide poor habitat, regardless of slope (SI = 0.1) (Prosser and Brooks, 1998). Stucker and Cuthbert (2000) also found that LOWA were nesting along moderately steep stream banks (average slop = 69°). LOWA nests in this Minnesota study site were typically within 1.4 meters of the stream and 1.3 meters above the stream surface (Stucker and Cuthbert, 2000). Maple leaves were prominent nesting material in this study (Stucker and Cuthbert, 2000). In a 2020 study on the indirect effects of an invasive insect on LOWA nest survival, Bryant et al. (2020) found that nest site selection was associated with the interaction of exposed live roots and hemlock condition – if hemlock condition was poor due to infestation, nests were more likely to be constructed in roots. These findings further highlight the potential for exposed roots to facilitate nesting.

Other features

Aside from the components mentioned above (forest area, forest overstory structure and composition, canopy cover, successional stage, riparian vegetation and understory structure, stream morphology, proximity to anthropogenic disturbance, prey availability, and nesting) several other features have been linked to LOWA breeding success and habitat suitability.

Mattsson and Cooper found that rainfall was the main driver of LOWA reproductive success in a 2009 Georgia study. In this study, DSR was highest when rainfall was moderate during the nesting season (3-10 mm day^{-1}). Nestling survival, however, was maximized when rainfall was high (>14 mm day^{-1}). The researchers suggest that food availability is highest with moderate to high levels of rainfall, potentially leading to higher reproductive success.

Fire, a common land management practice (particularly in the WGCPO and southeastern US), has been linked in LOWA presence in a 2014 study comparing avian communities in burned versus unburned forest stands in Nebraska towards the northwest periphery of the LOWAs range. Jorgensen et al. (2014) only detected LOWA in burned forest stands, with no detections in any of the unburned stands over the three-year study period. These findings suggest that LOWA may be avoiding forest areas with dense, well-developed understories, and may have important implications for the WGCPO, where burns are frequently incorporated in forest management.

Conclusion

The information provided in this summary is meant to serve as a guide for land managers, or anyone interested in understanding key LOWA breeding habitat characteristics. While every effort was made to ensure the information provided here represents a comprehensive compilation and synthesis of literature relevant to LOWA breeding habitat, it is possible that pertinent information was missed, and therefore unintentionally omitted from this summary. The accompanying annotated bibliography is designed to provide a more in-depth representation of the studies and works cited in this summary; however, the reader may have to refer to the original source to obtain more specific information (e.g., detailed methodology).

REFERENCES

Barnes, K. B., N. Ernst, M. Allen, T. Master, and R. Lausch. 2018. Louisiana Waterthrush Density and Productivity in Hemlock-dominated Headwater Streams: The Influence of Stream Morphology. Northeastern Naturalist 25:587–598.

Bent, A. C. 1963. Life Histories of North American wood warblers, part two. Dover Publishing, Inc., New York, NY.

Bryant, L. C., T. A. Beachy, and T. J. Boves. 2020. An invasive insect, hemlock woolly adelgid, indirectly impacts Louisiana Waterthrush nest site selection and nest survival in the southern Appalachians. Condor 122:1–16.

Chapman, M., J. R. Courter, P. E. Rothrock, and E. Science. 2015. Riparian Width and Neotropical Avian Species Richness in the Agricultural Midwest. Proceedings of the Indiana Academy of Science 124:80–88.

Conner, Richard N., Via J. W., P. I. D. 1979. Effects of pine-oak clearcutting on winter and breeding birds in Southwestern Virginia. Wilson Bulletin 91:301–316.

Conner, R. N., and J. G. Dickson. 1997. Relationships between bird communities and forest age, structure, species composition and fragmentation in the West Gulf Coastal Plain. Texas Journal of Science 49:123–138.

Craig, R. J. 1984. Comparative Foraging Ecology of Louisiana and Northern Waterthrushes. The Wilson Bulletin 96:173–183. <https://www.jstor.org/stable/4161910%0AJSTOR>.

Dickson, J. G., F. R. Thompson, R. N. Conner, and K. E. Franzreb. 1999. Effects of silviculture on neotropical migratory birds in central and southeastern oak-pine forests. NCASI Technical Bulletin 134–135.

Eaton, S. W. 1958. A life history study of the Louisiana Waterthrush. Wilson Bulletin1 70:210–235.

Farwell, L. S., P. B. Wood, D. J. Brown, and J. Sheehan. 2019. Proximity to unconventional shale gas infrastructure alters breeding bird abundance and distribution. Gerontologist 59:1–20.

Frantz, M. W., P. B. Wood, S. C. Latta, and A. B. Welsh. 2020. Epigenetic response of Louisiana Waterthrush Parkesia motacilla to shale gas development. Ibis 162:1211–1224.

Frantz, M. W., P. B. Wood, and G. T. Merovich. 2018*a*. Demographic characteristics of an avian predator, Louisiana Waterthrush (Parkesia motacilla), in response to its aquatic prey in a Central Appalachian USA watershed impacted by shale gas development. PLoS ONE 13:1–19.

Frantz, M. W., P. B. Wood, J. Sheehan, and G. George. 2018*b*. Demographic response of Louisiana Waterthrush, a stream obligate songbird of conservation concern, to shale gas development. Condor 120:265–282.

Frantz, M. W., P. B. Wood, J. Sheehan, and G. George. 2019. Louisiana Waterthrush (Parkesia motacilla) survival and site fidelity in an area undergoing shale gas development. Wilson Journal of Ornithology 131:84–95.

Hamel, P. B. 1992. The land managers guide to the birds of the south. The Nature Conservancy, Chapel Hill, NC.

Hayden, T. J., J. Faaborg, and R. L. Clawson. 1985. Estimates of minmum area requirements for Missouri forest birds. Transactions of the Missouri Academy of Science 19:11–22.

Hyder. 2002. Investigation of the relationship between floodplain geomorphology and riparian congbird communities. University of Georgia.

Jorgensen, J. G., M. A. Brogie, W. R. Silcock, and J. Rink. 2014. Breeding Bird Diversity, Abundance and Density at Indian Cave and Ponca State Parks , Nebraska , 2012-2014. 2012–2014.

Kilgo, J. 2018. Effect of Stand Width and Adjacent Habitat on Breeding Bird Communities in Bottomland Hardwoods Author (s): John C . Kilgo , Robert A . Sargent , Brian R . Chapman and Karl V . Miller Published by : Wiley on behalf of the Wildlife Society Stable URL : h. 62:72–83.

Latta, K. 2009. What determines success? Breeding habitat characteristics of the Louisiana waterthrush (Seiurus motacilla). 1–15.

Latta, S. C., L. C. Marshall, M. W. Frantz, and J. D. Toms. 2015. Evidence from two shale regions that a riparian songbird accumulates metals associated with hydraulic fracturing. Ecosphere 6.

Loman, Z. G., W. V. Deluca, D. J. Harrison, C. S. Loftin, B. W. Rolek, and P. B. Wood. 2018. Landscape capability models as a tool to predict fine-scale forest bird occupancy and abundance. Landscape Ecology 33:77–91. Springer Netherlands.

Marshall, L. C. 2012. Territories, territoriality, and conservation of the Louisiana Waterthrush and its habitat, the watershed of the upper Buffalo National River. Igarss 2014 1–223.

Mason, J., C. Moorman, G. Hess, and K. Sinclair. 2007. Designing suburban greenways to provide habitat for forest-breeding birds. Landscape and Urban Planning 80:153–164.

Mattsson, B. J., and R. J. Cooper. 2006. Louisiana waterthrushes (Seiurus motacilla) and habitat assessments as cost-effective indicators of instream biotic integrity. Freshwater Biology 51:1941–1958.

Mattsson, B. J., and R. J. Cooper. 2007. Which life-history components determine breeding productivity for individual songbirds? A case study of the Louisiana waterthrush (Seiurus motacilla). Auk 124:1186–1200.

Mattsson, B. J., and R. J. Cooper. 2009. Multiscale analysis of the effects of rainfall extremes on reproduction by an obligate riparian bird in urban and rural landscapes. Auk 126:64–76.

Mattsson, B. J., S. C. Latta, R. J. Cooper, and R. S. Mulvihill. 2011. Latitudinal variation in reproductive strategies by the migratory Louisiana Waterthrush. Condor 113:412–418.

McClure, C. J. W., and G. E. Hill. 2012. Dynamic versus static occupancy: How stable are habitat associations through a breeding season? Ecosphere 3:art60.

Means, J. L., and K. E. Medley. 2010. Old Regrowth forest patches as habitat for the conservation of avian diversity in a southwest Ohio landscape. Ohio Journal of Science 110:86–93.

Mueller, A., D. Twedt, and C. Loesch. 1995. Development of management objectives for breeding birds in the Mississippi Alluvial Valley. Proc. of the 1995 Partners in Flight … 1–15. <http://www.lmvjv.org/library/research_docs/2000 RMRS-P-16_12-17 Mueller Twedt Loesch.PDF>.

Mulvihill, R. S., F. L. Newell, and S. C. Latta. 2008. Effects of acidification on the breeding ecology of a stream-dependent songbird, the Louisiana waterthrush (Seiurus motacilla). Freshwater Biology 53:2158–2169.

Mulvihill, R. S., F. L. Newell, S. C. Latta, B. J. Mattsson, R. J. Cooper,. 2009. Effects of acidification on the breeding ecology of a stream-dependent songbird, the Louisiana waterthrush (Seiurus motacilla). Condor 51:412–418. <https://www.fws.gov/r5gomp/gom/habitatstudy/metadata2/louisiana_waterthrush_model.htm>.

Nott, M. P., D. F. DeSante, and N. Michel. 2003. Management strategies for reversing declines in landbirds of conservation concern on military installations: A landscape-scale analysis of maps data. A report to the U.S. Department of Defense Legacy Resources Management Program. 123.

Parnell,J.F.. 2010. Habitat Relations of the Parulidae during Spring Migration. University of California Press on behalf of the American Ornithologists ' Union Stable URL : http://www.jstor.org/stable/4083411. Spring 86:505–521.

PEAK, R. G., and F. R. THOMPSON. 2006. Factors Affecting Avian Species Richness and Density in Riparian Areas. Journal of Wildlife Management 70:173–179.

Pennington, D. N., and R. B. Blair. 2011. Habitat selection of breeding riparian birds in an urban environment: Untangling the relative importance of biophysical elements and spatial scale. Diversity and Distributions 17:506–518.

Prosser, D. J., and R. P. Brooks. 2011. A Verified Habitat Suitability Index for the Louisiana Waterthrush (Un Índice Verificable de Adecuación de Habitat Para Seiurus motacilla) Published by : Blackwell Publishing on behalf of Association of Field Ornithologists Stable URL : http://www.jstor. Habitat 69:288–298.

Robbins, C. S., J. R. Sauer, R. S. Greenberg, and S. Droege. 1989. Population declines in North American birds that migrate to the neotropics. Proceedings - National Academy of Sciences, USA 86:7658–7662.

Robbins, S. C., D. K. Dawson, and B. A. Dowell. 1989. Habitat Area Requirements of Breeding Forest Birds of the Middle Atlandtic States. Wildlife Monographs 103:1–34.

Robinson, S. K., and D. S. Wilcove. 1999. Forest fragmentation in the temperate zone and its effects on migratory songbirds. NCASI Technical Bulletin 2:451.

Sauer, J. R. E., J. E. Hines, K. L. Fallon, J. Pardieck, D.J., Ziolkowski, and W. A. Link. 2014. The North American Breeding Bird Survery, Results and Analysis 1966-2012. Version 02.19.2014. Laurel, MD. <http://www.mbr-pwrc.usgs.gov/bbs/bbs.html>.

Schulz, C. A., D. M. Leslie, R. L. Lochmiller, and D. M. Engle. 1992. Herbicide birds effects on cross timbers breeding AND. 45.

Skinner, C. 2003. A breeding bird survey of the natural areas at Holden Arboretum. Ohio Journal of Science 103:98–110.

Society, W., T. Journal, and W. Management. 1995. Nongame Bird Use of Habitat in Central Appalachian Riparian Forests Author (s): Norman L . Murray and F . Stauffer Published by : Wiley on behalf of the Wildlife Society Stable URL : http://www.jstor.com/stable/3809118. 59:78–88.

Stucker, J. H., and F. J. Cuthbert. 2000. Biodiversity of southeastern Minnesota forested streams: relationships between trout habitat improvement practices, riparian communities and the Louisiana waterthrush. Natural Heritage and Nongame Wilidlife Program 1–146.

Thompson, B. n.d. Process for establishing priority refuge resources of concern.

Thompson, F. R. 1996. Management of midwestern landscapes for the conservation of neotropical migratory birds. F. R. Thompson, editor. U.S. Department of Agriculture, U.S. Forest Service, North Central Forest Experimental Station.

Tirpak, J M, D. T. Jones-farrand, F. R. Thompson, D. J. T. Iii, W. B. Uihlein, and Iii. 2009. b. Multiscale habitat suitability index models for priority landbirds in the Central Hardwoods and West Gulf Coastal Plain/Ouachitas Bird Conservation Regions. U.S. Department of Agriculture, Forest Service General Technical Report NRS-49, Northern Research Station, Newtown Square, Pennsylvania, USA.

Tirpak, John M., D. T. Jones-Farrand, F. R. Thompson, D. J. Twedt, C. K. Baxter, J. A. Fitzgerald, and W. B. Uihlein. 2009. Assessing Ecoregional-Scale Habitat Suitability Index Models for Priority Landbirds. Journal of Wildlife Management 73:1307–1315.

Trevelline, B. K., S. C. Latta, L. C. Marshall, T. Nuttle, and B. A. Porter. 2016. Molecular analysis of nestling diet in a long-distance Neotropical migrant, the Louisiana Waterthrush (Parkesia motacilla). Auk 133:415–428.

Trevelline, B. K., T. Nuttle, B. D. Hoenig, N. L. Brouwer, B. A. Porter, and S. C. Latta. 2018. DNA metabarcoding of nestling feces reveals provisioning of aquatic prey and resource partitioning among Neotropical migratory songbirds in a riparian habitat. Oecologia 187:85–98. Springer Berlin Heidelberg. <https://doi.org/10.1007/s00442-018-4136-0>.

Twedt, D. J., J. M. Tirpak, D. T. Jones-Farrand, F. R. Thompson, W. B. Uihlein, and J. A. Fitzgerald. 2010. Change in avian abundance predicted from regional forest inventory data. Forest Ecology and Management 260:1241–1250. Elsevier B.V. <http://dx.doi.org/10.1016/j.foreco.2010.07.027>.

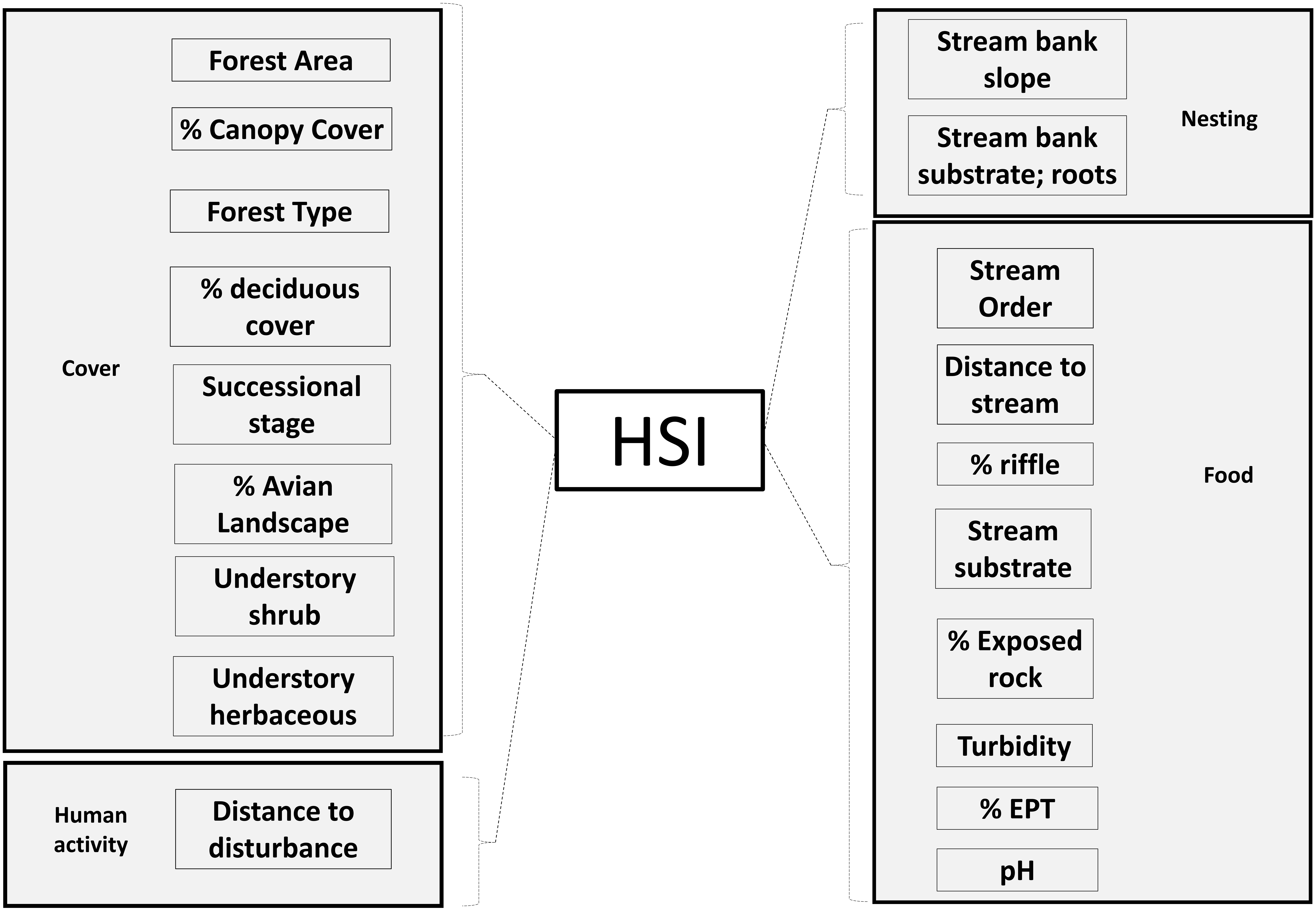
Vance, M. D., L. Fahrig, and C. H. Flather. 2003. Effect of reproductive rate on minimum habitat requirements of forest-breeding birds. Ecology 84:2643–2653.

Wood, P. B., M. W. Frantz, and D. A. Becker. 2016. Louisiana waterthrush and benthic macroinvertebrate response to shale gas development. Journal of Fish and Wildlife Management 7:423–433.

Louisiana Waterthrush HSI Model

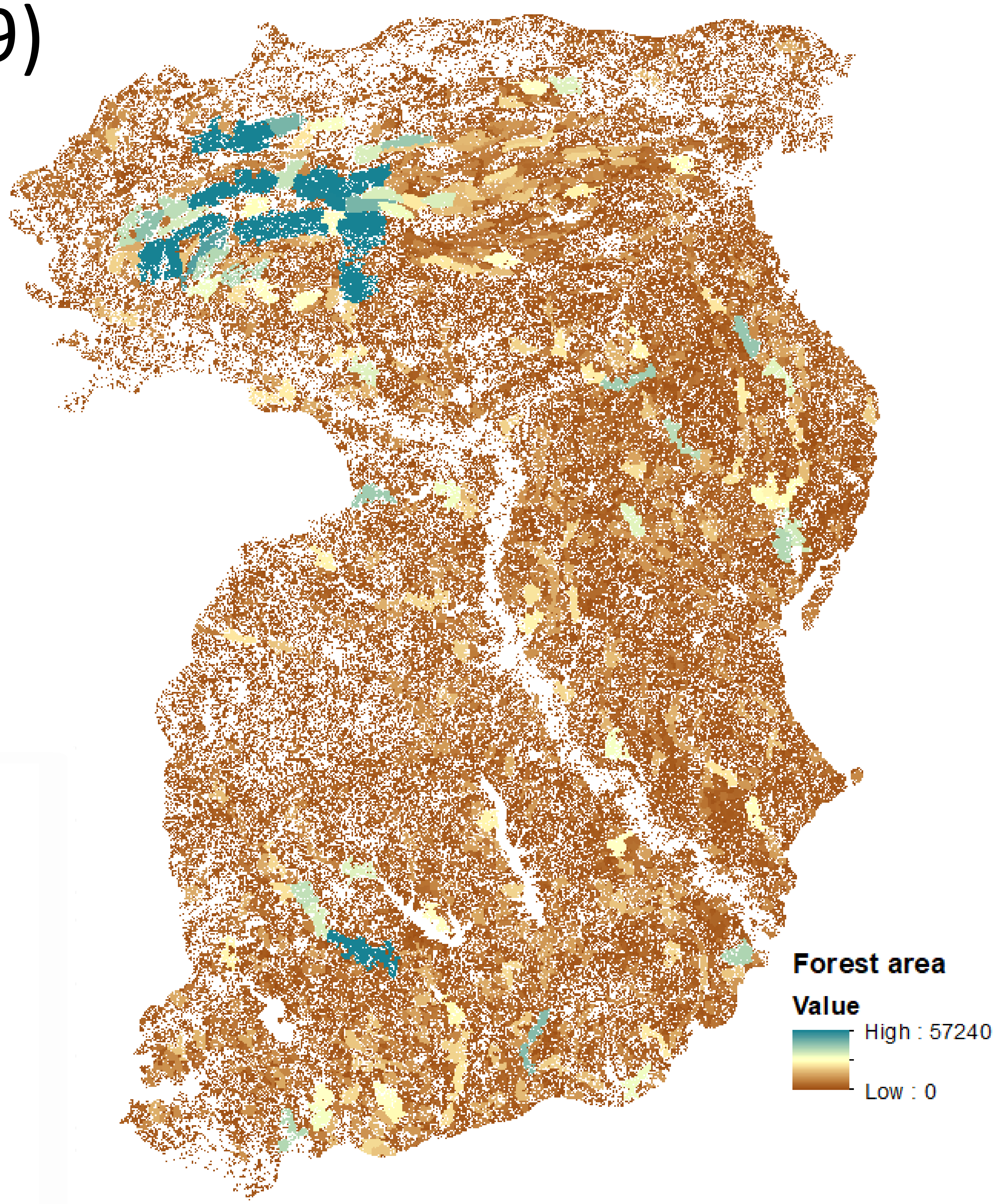
Lower Mississippi Valley
JOINT VENTURE

Louisiana Waterthrush Habitat Suitability – Conceptual Model



Forest Area:

1. Lumped 4 forest classes (NLCD 2019)
   - deciduous
   - evergreen
   - mixed
   - woody wetland
2. Calculated forest patch size



Forest area (ha)	SI score
42.2	0.0
350	0.5
3,200	1.0

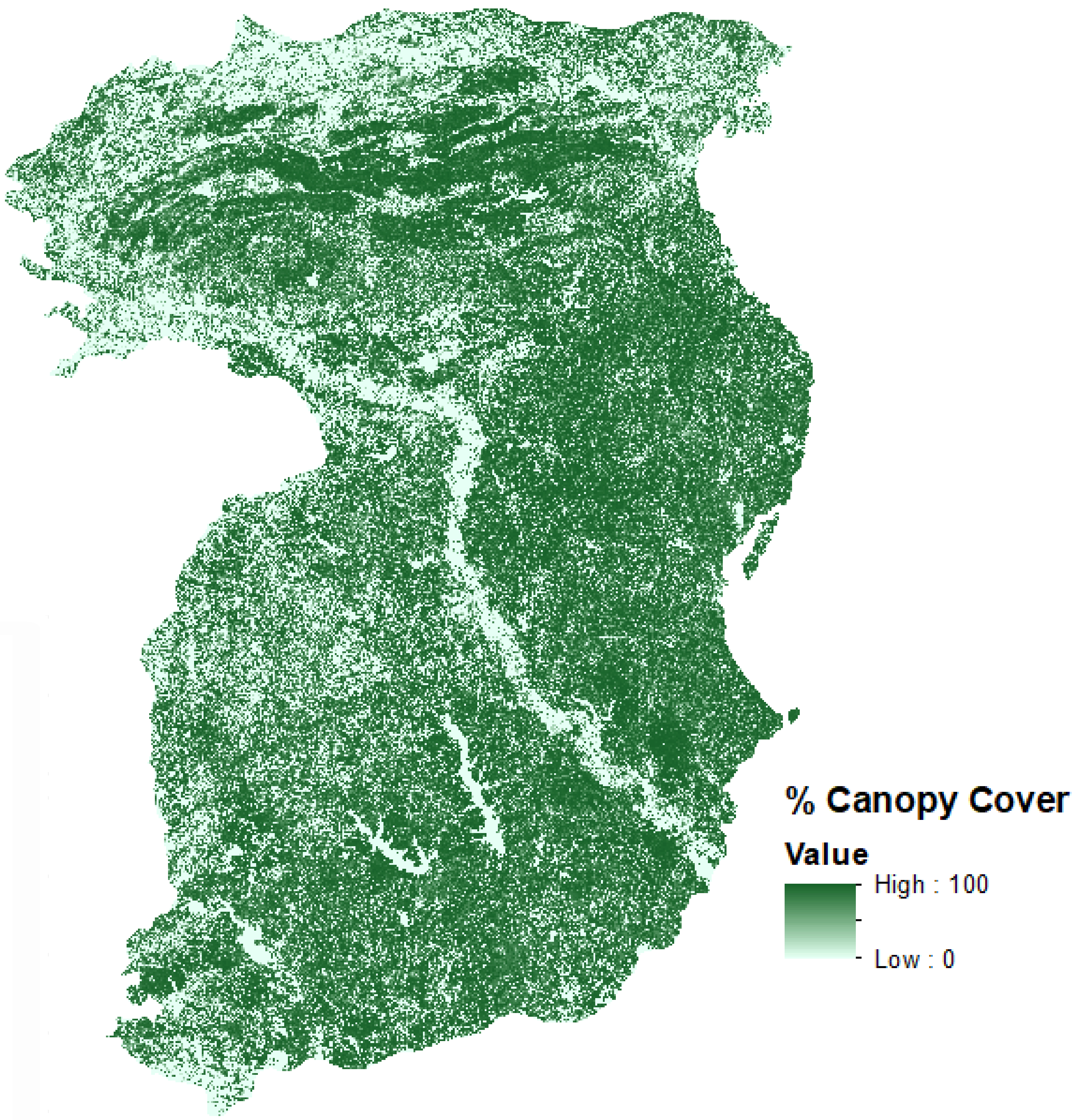
*From Tirpak 2009 (Robbins 1989, Hayden 1985)

Percent Canopy Cover:

1. NLCD 2016 percent canopy cover

Percent canopy cover	SI score
>80%	1.0
60-80%	0.7
40-59%	0.2
<40%	0.0

*From Prosser and Brooks

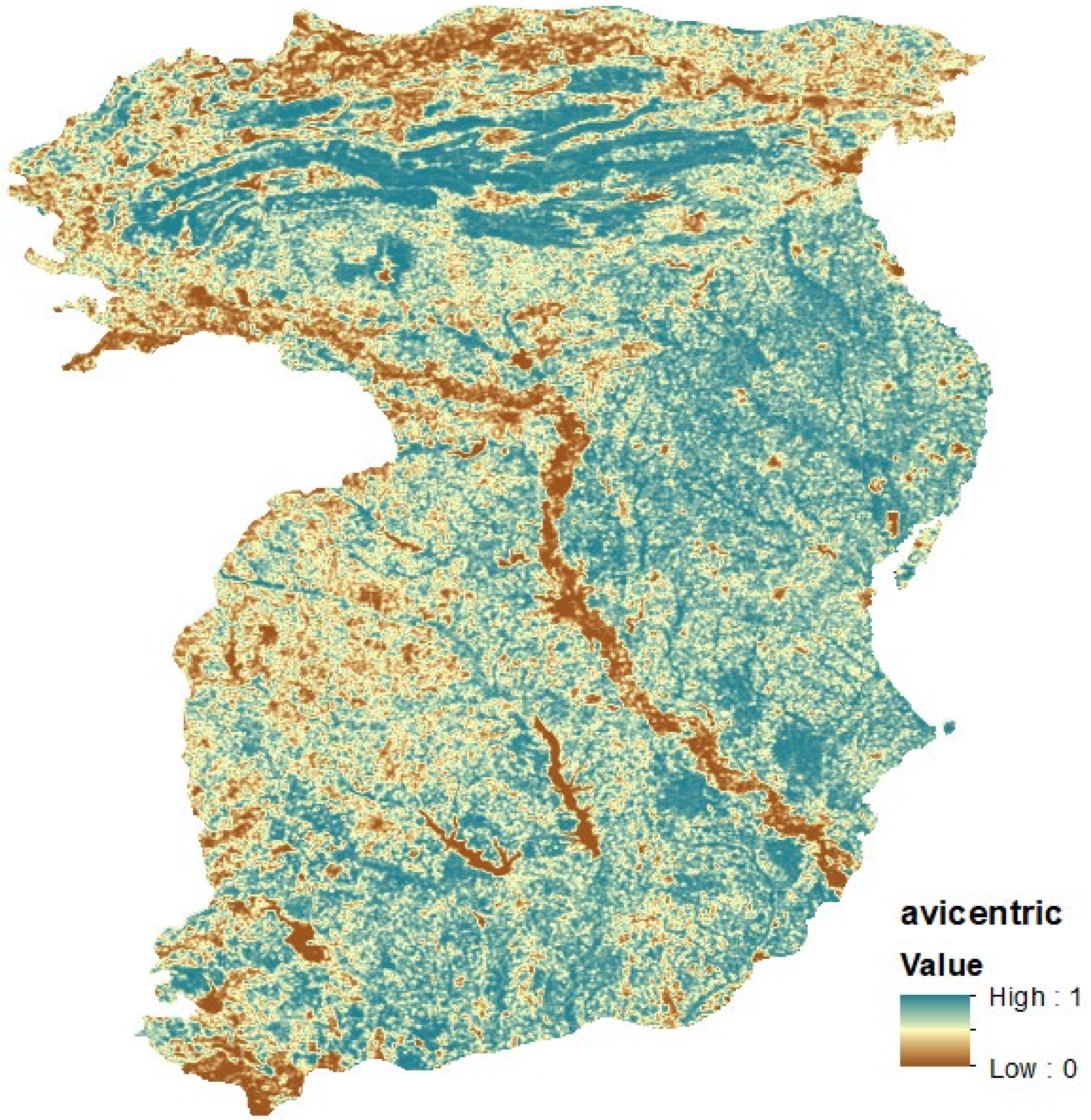


% Avian Landscape:

1. NLCD 2019 binary forest layer
2. Calculate % forest within a 1 km radius

% Forest in 1-km radius	SI score
0	0.00
10	0.00
20	0.05
30	0.10
40	0.25
50	0.50
60	0.75
70	0.90
80	0.95
90	1.00
100	1.00

*From Tirpak 2009

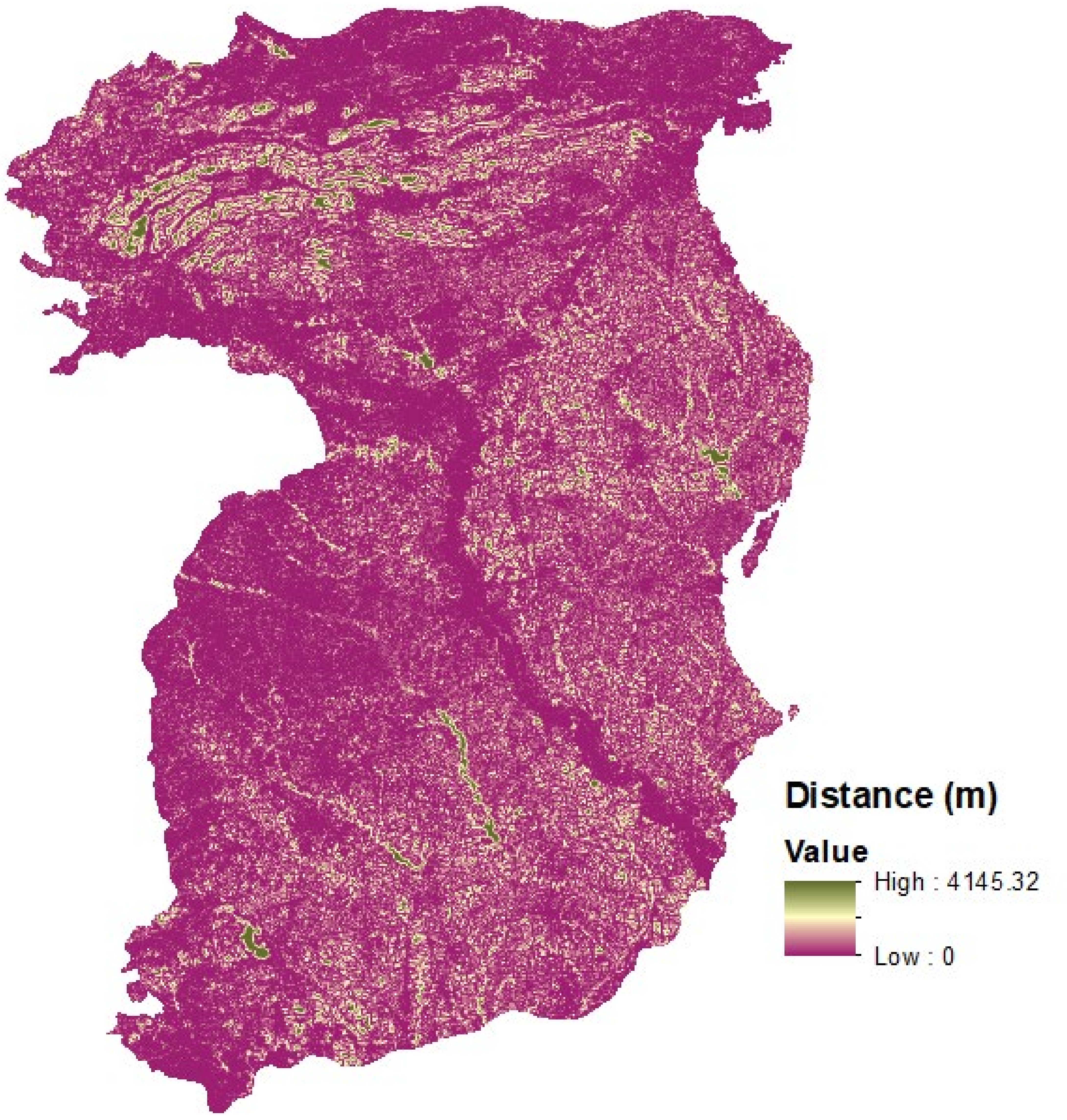


Distance to Disturbance:

1. Identify classes defining anthropogenic disturbance (NLCD 2019)
2. Calculate distance to anthropogenic disturbance

Distance to disturbance (m)	SI score
0-60	0.0
60-90	0.2
90-120	0.5
120-300	0.8
300+	1.0

*From Tirpak 2009



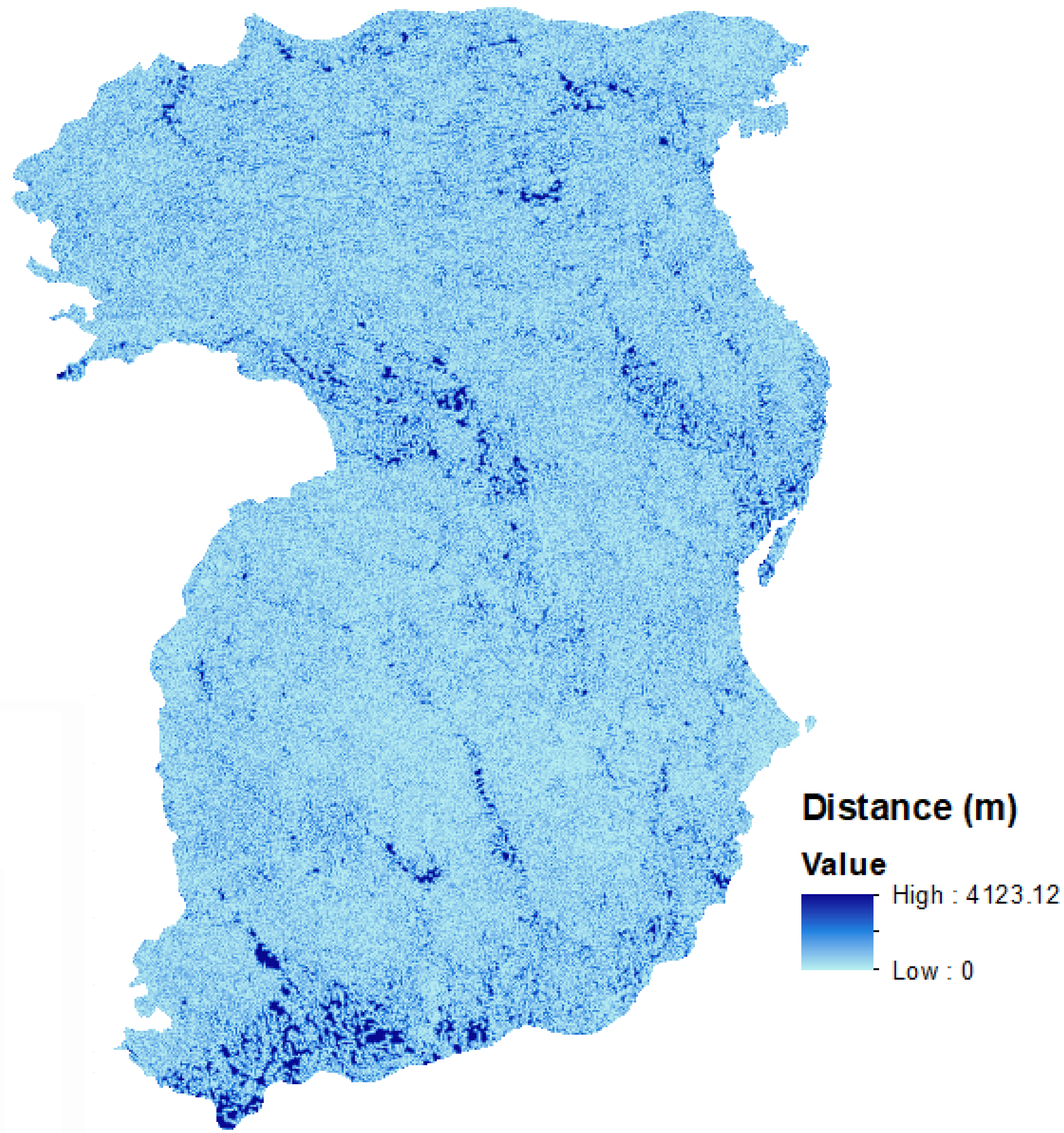
Also…Eaton 1958, Thompson 1996, Mattsson and Cooper 2006, Mulvihill et al. 2009, and Frantz et al. 2018*b*

Distance to Stream:

1. Identify 1st and 2nd order streams (NHD-HR and NHD +)
2. Calculate distance to 1st and 2nd order stream

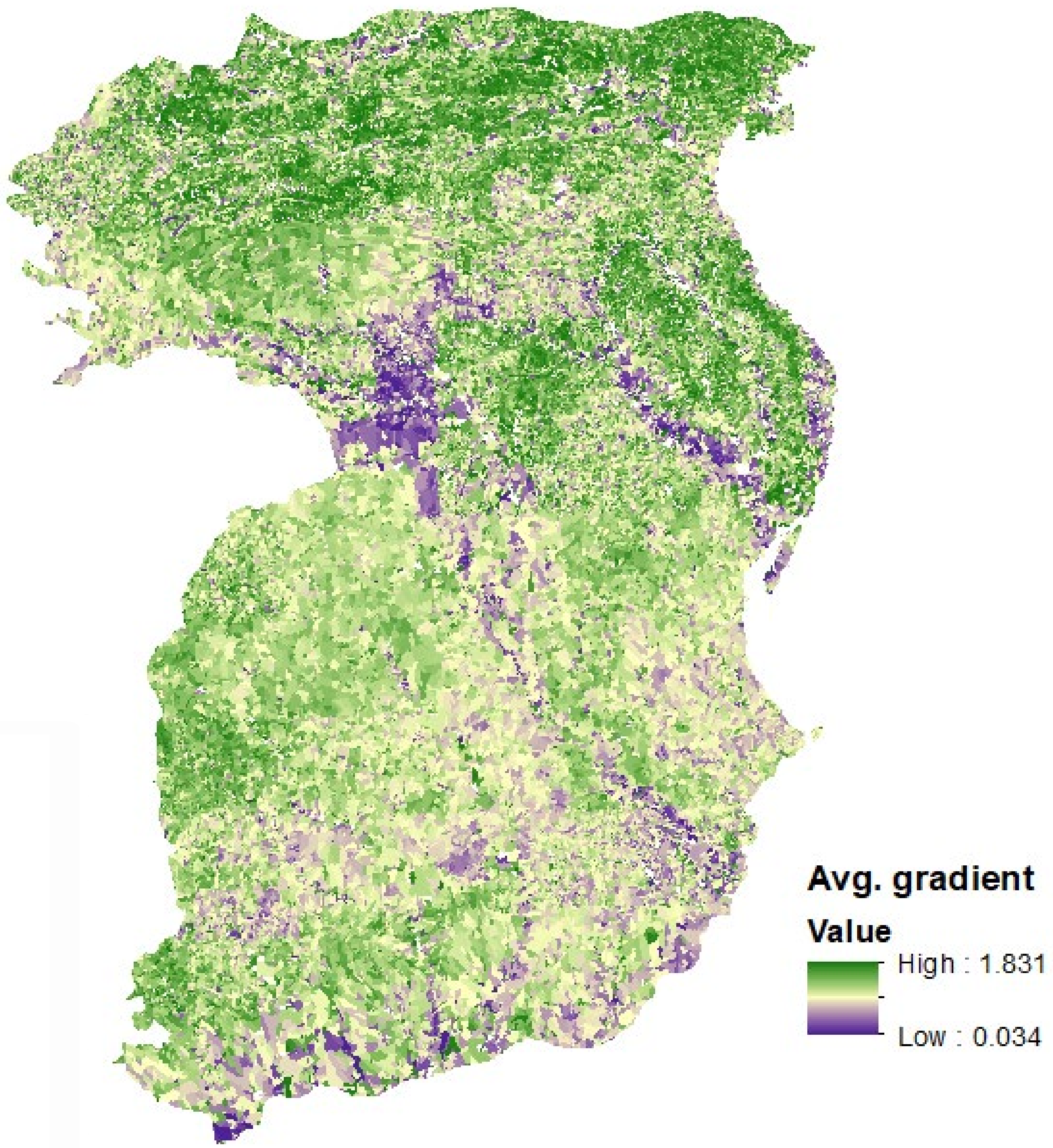
Distance to stream (m)	SI score
0-30	1.0
31-60	0.5
> 60	0.0

*From Tirpak 2009



Stream morphology (riffles and substrate) :

1. Gradient of 1st and 2nd order streams (NHD-HR and NHD +; NED) averaged for each 'catchment'



Average Stream Gradient	SI
0.00-0.030	0.20
0.3 +	1.00

*Derived from Jowett, 1993, and SARP report and personal communication

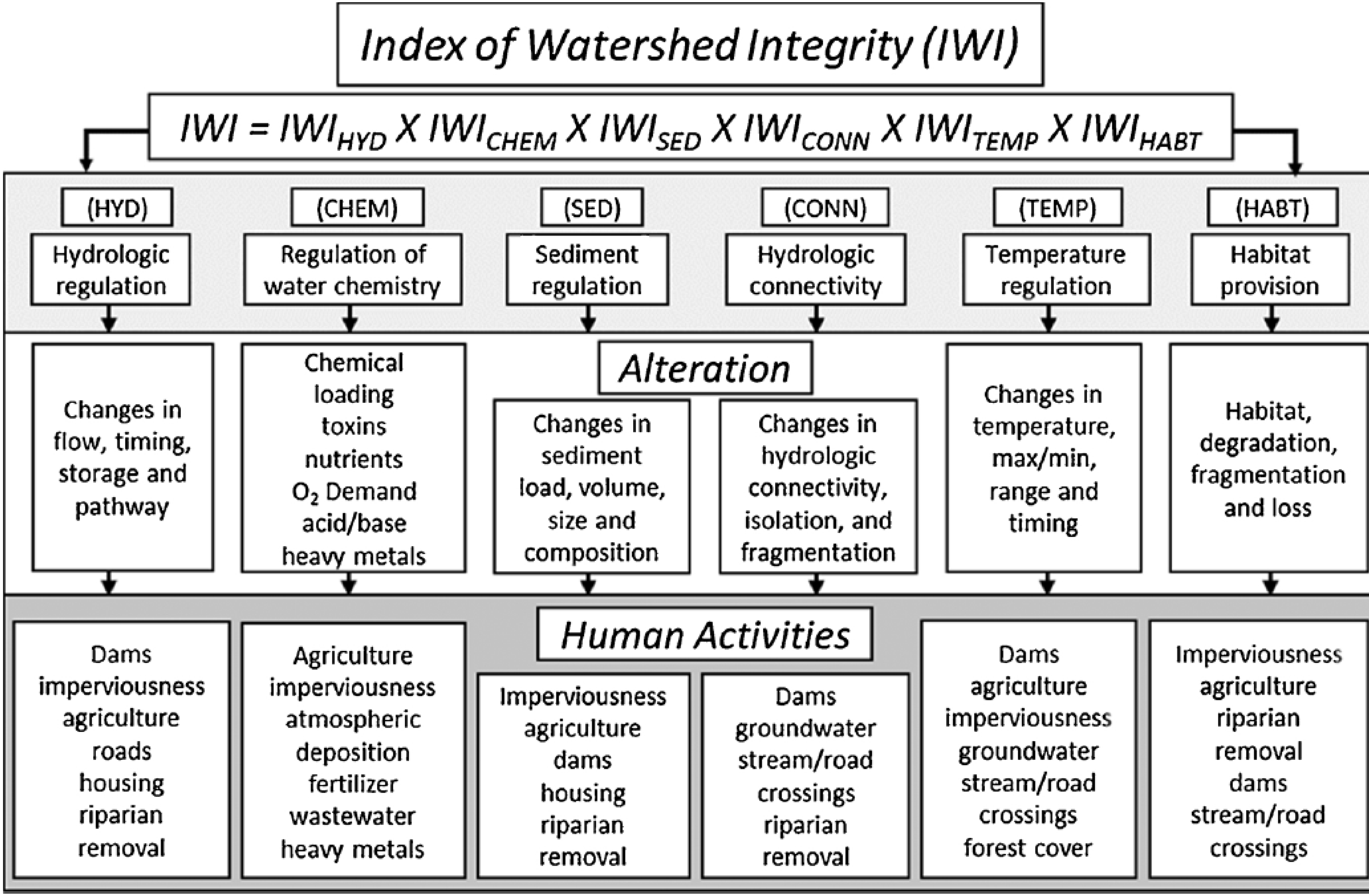


Fig. 1. Conceptual model of the calculation of the Index of Watershed Integrity including human activities that produce stress and degrade key functions in watersheds.

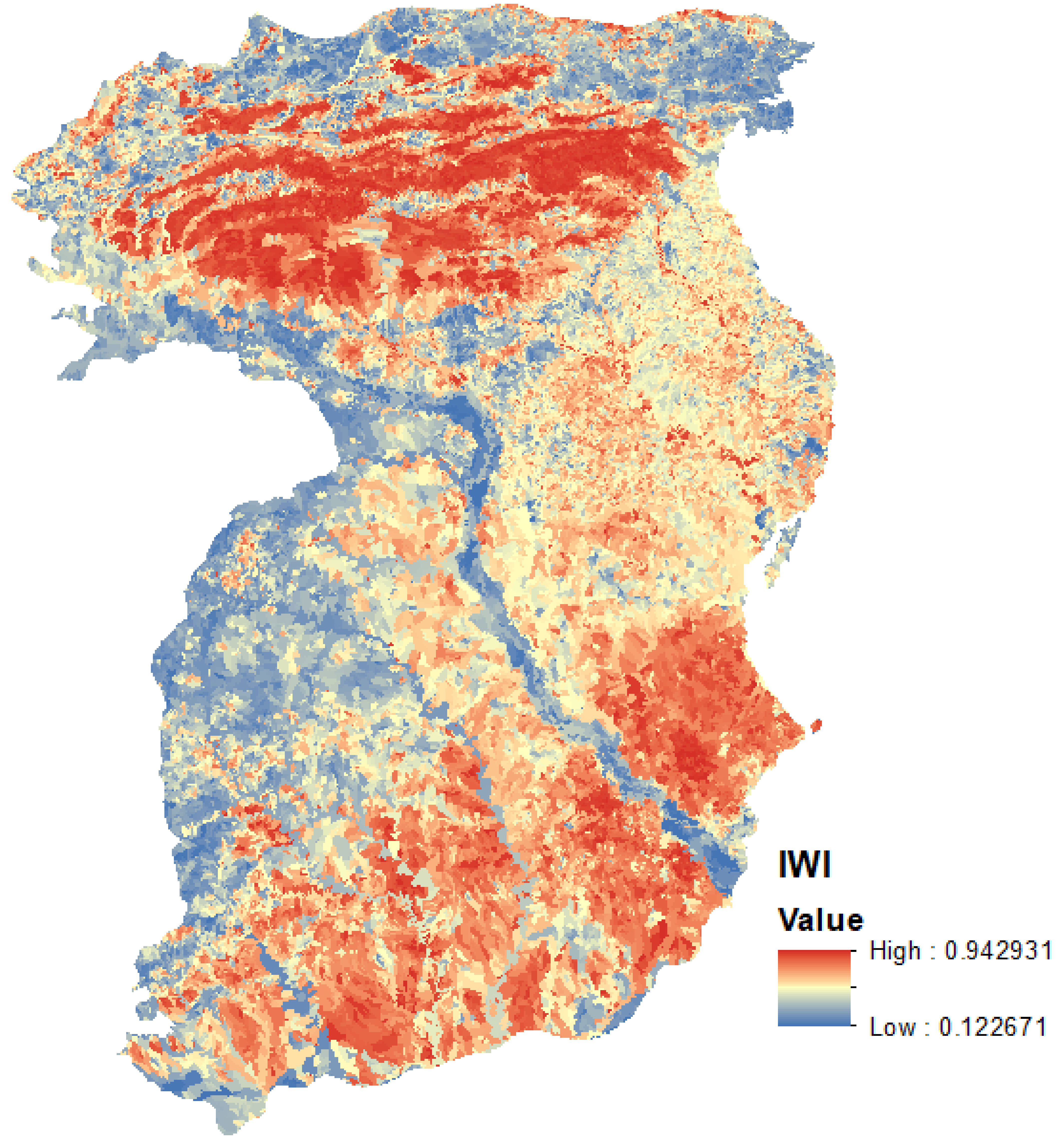
Thornbrugh et al. 2017

Water Quality:

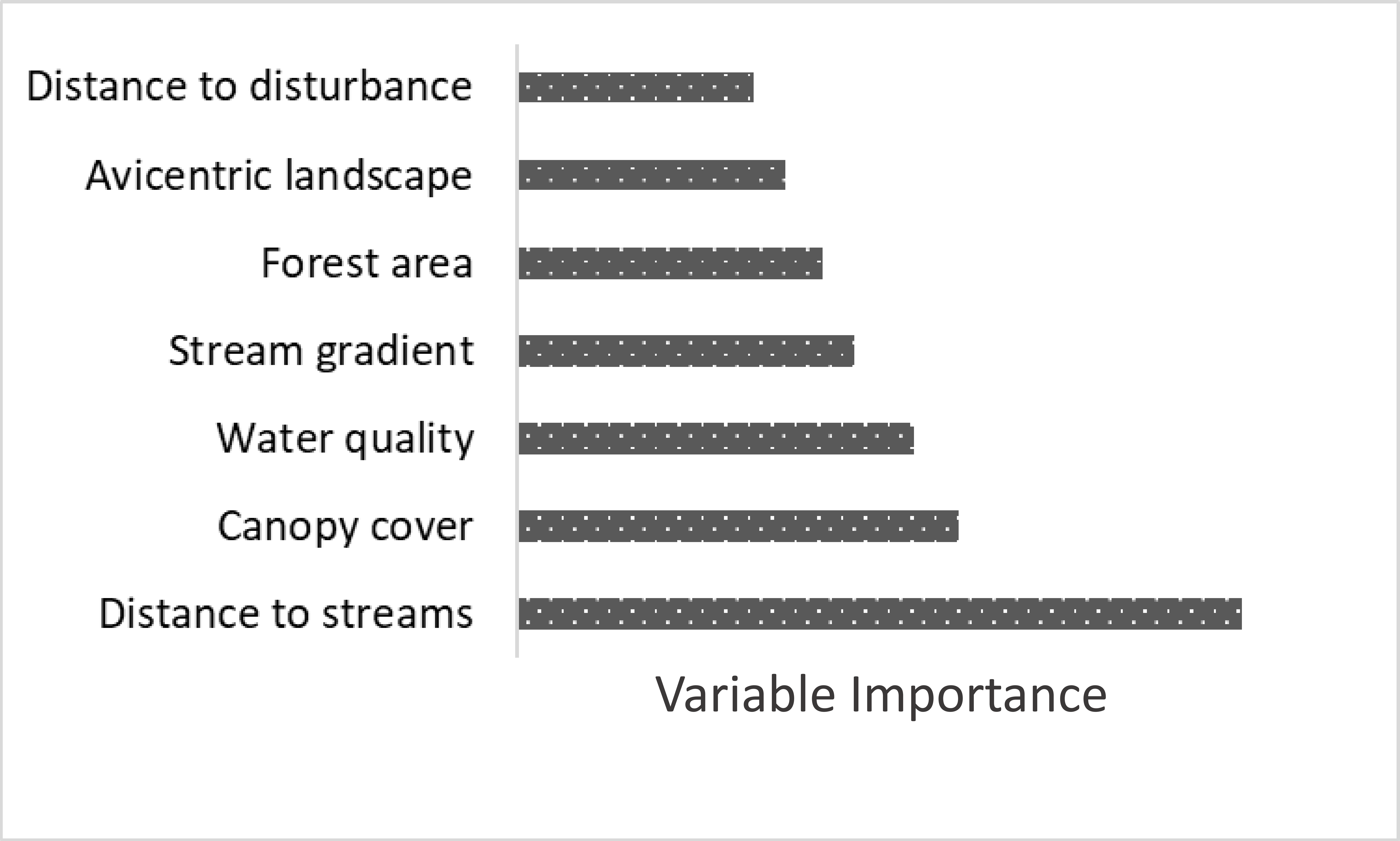
1. Index of watershed integrity (IWI) from StreamCat dataset (EPA)

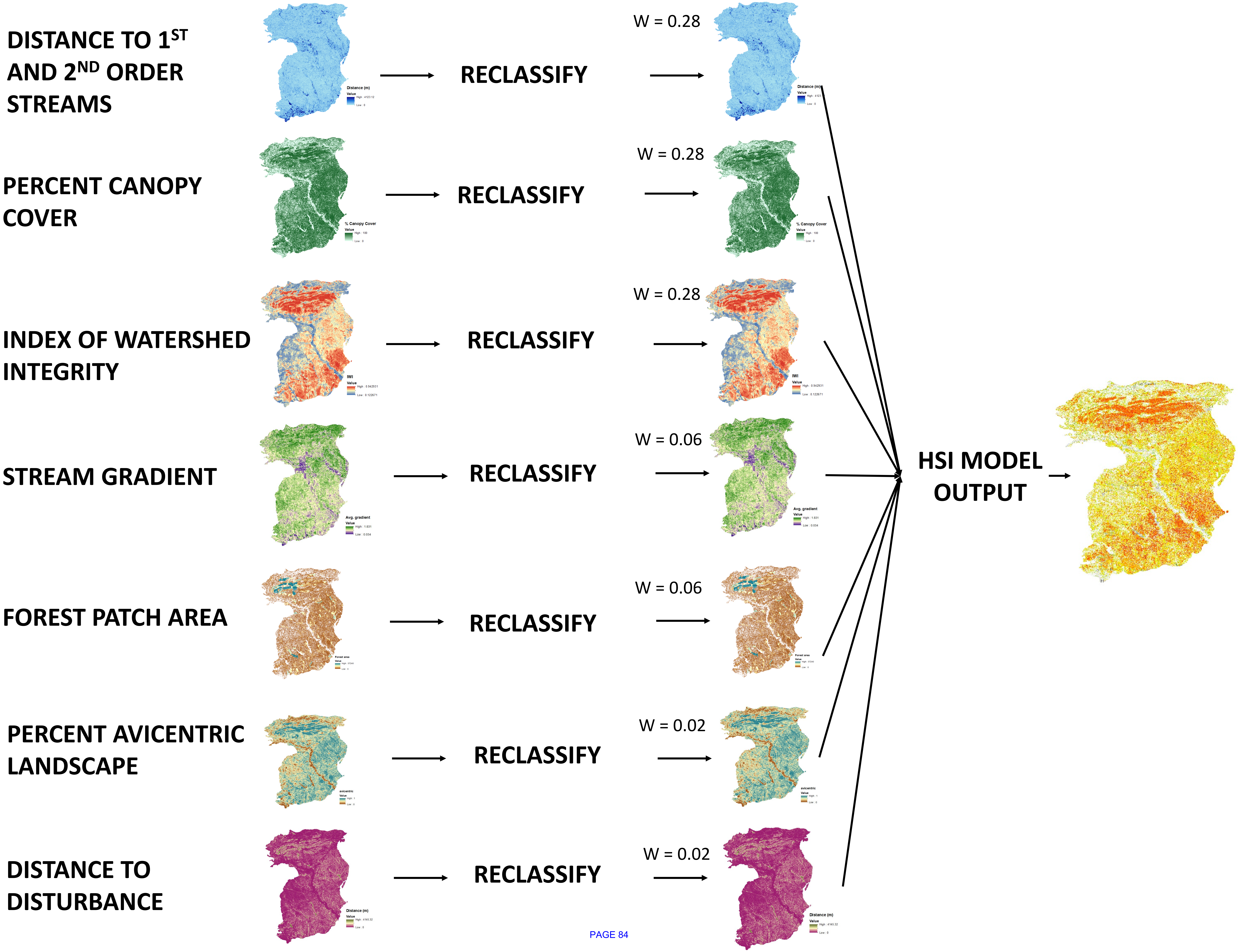
Index of Water Integrity (IWI)	SI score
0.0-0.2	0.10
0.2-0.5	0.30
0.5-0.7	0.50
0.7 +	1.00

* Derive from descriptive statistics from LOWA occurrence points IWI values

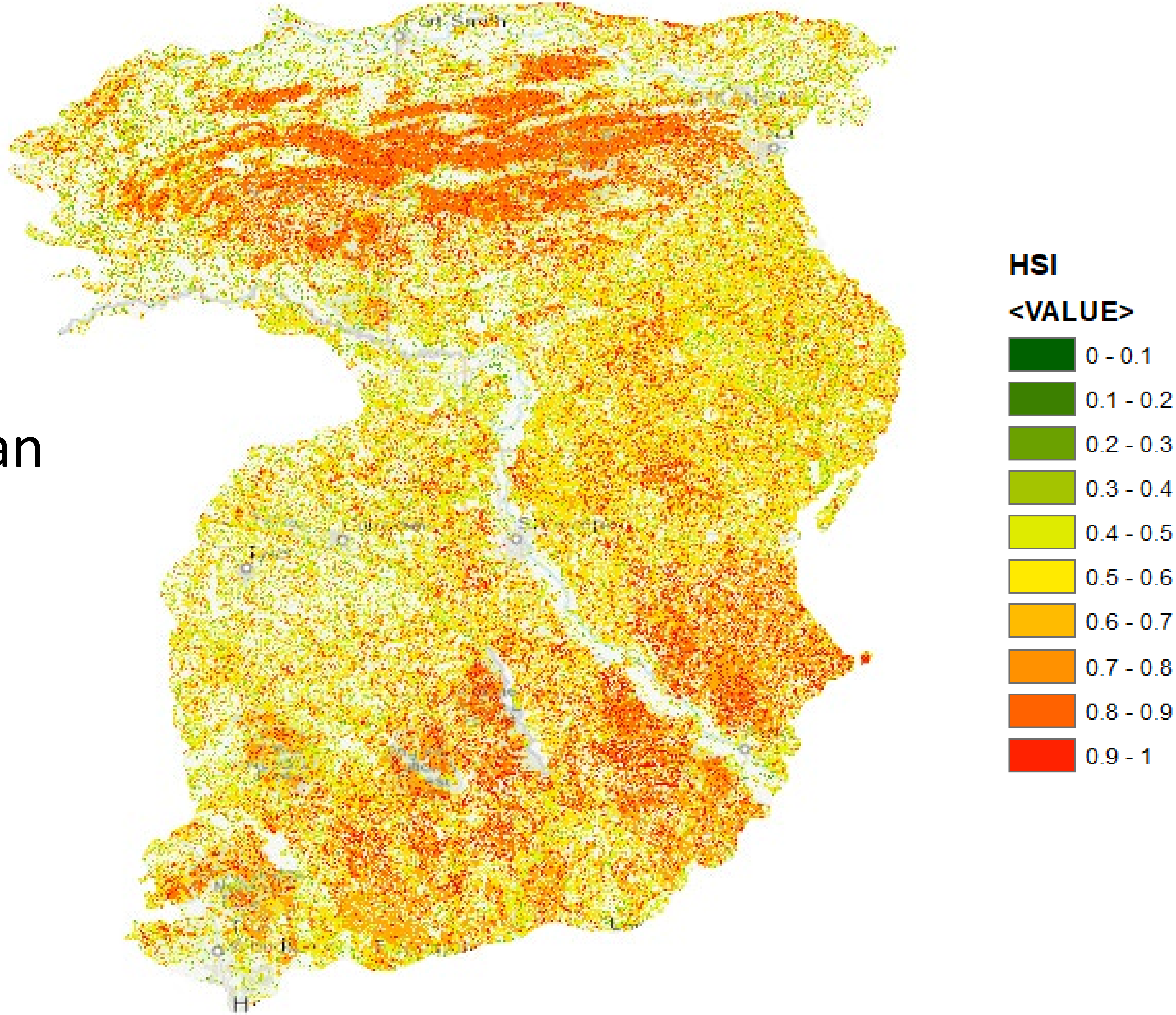


Variable Importance:



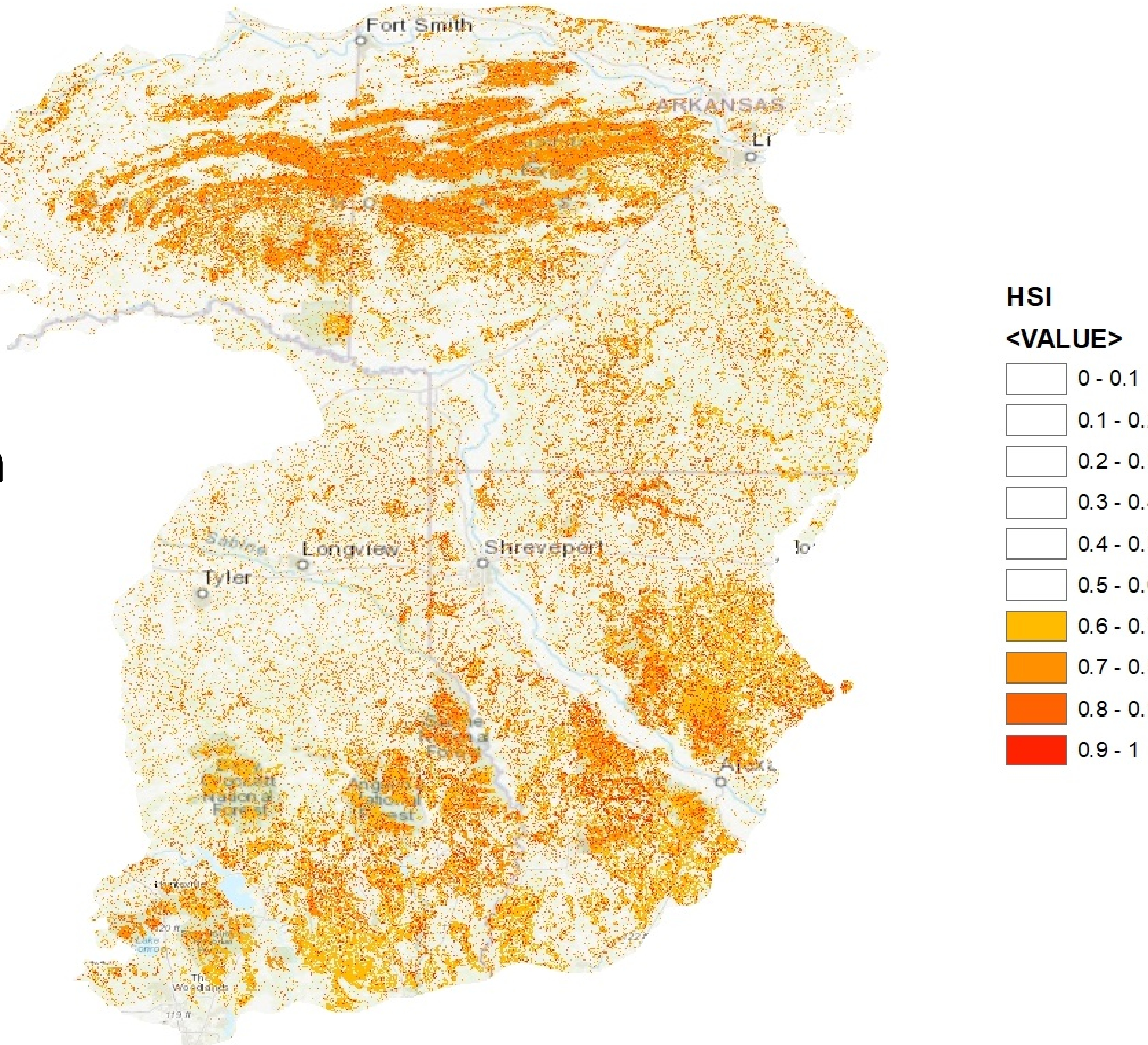

DISTANCE TO 1ST AND 2ND ORDER STREAMS
PERCENT CANOPY COVER
INDEX OF WATERSHED INTEGRITY
STREAM GRADIENT
FOREST PATCH AREA
PERCENT AVICENTRIC LANDSCAPE
DISTANCE TO DISTURBANCE
RECLASSIFY
RECLASSIFY
RECLASSIFY
RECLASSIFY
RECLASSIFY
RECLASSIFY
RECLASSIFY
W = 0.28
W = 0.28
W = 0.28
W = 0.06
W = 0.06
W = 0.02
W = 0.02
HSI MODEL OUTPUT

Geometric Mean model:



$$\frac{(SI_{1w} + SI_{2w} + SI_{3w} + SI_{4w} + SI_{5w} + SI_{6w} + SI_{7w})}{7}$$

Geometric Mean model:



$$\frac{(SI_{1w} + SI_{2w} + SI_{3w} + SI_{4w} + SI_{5w} + SI_{6w} + SI_{7w})}{7}$$

Keith McKnight
Anne Mini
Blaine Elliot
Bill Bartush
Todd Jones-Farrand
Yvonne Allen
Emily Granstaff
John Faustini
Josh Pierce
Kristine Evans
Carlos Ramirez Reyes…

THANK YOU!!!

LOUISIANA WATERTHRUSH BREEDING HABITAT ANNOTATED BIBLIOGRAPHY

Lower Mississippi Valley Joint Venture
Janine Antalffy – *Directorate Fellow, USFWS*
Keith McKnight – *Coordinator*
Anne Mini – *Science Coordinator*
Blaine Elliot – *GIS Applications Biologist*

Barnes, K. B., N. Ernst, M. Allen, T. Master, and R. Lausch. 2018. LOWA Density and Productivity in Hemlock-dominated Headwater Streams: The Influence of Stream Morphology. Northeastern Naturalist 25:587–598.

Background: The Louisiana Waterthrush (LOWA) has been considered an excellent indicator of riparian habitat quality. Density and reproductive success are measurable and may be more useful than LOWA presence/absence in indicating habitat quality. Differences in stream morphologies may drive differences in reproductive success, and certain morphologies may be associated with higher fitness.

Objectives: The goal of this study was to associate LOWA reproductive success with habitat quality in two types of stream morphologies – ravines and benches.

Methods: The researchers captured and banded LOWA along four headwater streams representing both ravine and bench stream morphologies over a four-year period in Eastern Hemlock dominated forests (2010 - 2013). Measured indicators of reproductive success included pairs per kilometer, fledglings per kilometer, nest success, and incidence of double brooding.

Location: Pike County, Pennsylvania

Findings: This study found that LOWA pair densities and fledging densities were significantly higher on streams characterized as benches than those characterized as ravines. Breeding pairs in bench territories also experienced higher nest success and higher incidence of double brooding.

Implications: By associating LOWA reproductive success with stream morphology, this study found that LOWA density and fitness was higher in bench streams than in ravine streams. This information indicated that bench stream morphologies provide highly suitable breeding habitat for the LOWA across the study site.

Topics: stream morphology, LOWA, reproductive fitness, Eastern Hemlock

Bent, A. C. 1963. Life Histories of North American wood warblers, part two. Dover Publishing, Inc., New York, NY.

Background: This work is part of a Bulletin series from the Smithsonian Institute presenting a comprehensive review of North American Avifauna, including natural and life history traits.

Objectives: Focusing on North American Wood Warblers (family Parulidae), the aim of this Bulletin was to synthesize available information regarding natural and life history traits of Wood Warblers in a systematic review.

Methods: The author compiled information obtained from experts for each species and presented a summary of current knowledge pertaining to natural and life history including courtship behavior, nesting behavior, egg characteristics, description of young, plumage characteristics, foraging ecology, general behavior, song, field marks, potential predators/parasites, fall migration, winter distribution and behavior, range and annual distribution.

Location: North America

Findings: This Bulletin presents a comprehensive and fundamental guide to biologically relevant characteristics of North American Wood Warblers.

Implications: Cited by many researchers, this source serves as a fundamental guide to many important natural and life history traits that are useful in informing conservation management and research.

Topics: North America, Wood Warblers, Parulidae, Passeriformes, life history, natural history

Bryant, L. C., T. A. Beachy, and T. J. Boves. 2020. An invasive insect, hemlock woolly adelgid, indirectly impacts LOWA nest site selection and nest survival in the southern Appalachians. Condor 122:1–16.

Background: An invasive insect, the hemlock wooly adelgid (HWA) is causing population declines in the Eastern Hemlock. The direct and indirect impacts of hemlock wooly adelgid invasion on forest birds is largely unknown. Most studies to date focus on avian community diversity, with little research investigating the response of individual species to declining hemlock populations. The LOWA is a riparian obligate songbird breeding in the eastern US. In parts of the LOWA range, Eastern Hemlock may concentrate along streams. The LOWA's preferred food source, aquatic macroinvertebrates from the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) are associated with these hemlock-filtered streams. LOWA also heavily exploit terrestrial lepidopterans while feeding nestlings, implying some dependence on the streambank and adjacent habitats.

Structurally, hemlocks may provide nesting habitat where roots are exposed along stream banks. The HWA invasion and resulting decline of hemlocks may be detrimental to the LOWA, a species which is known to be sensitive to habitat and ecosystem disturbances including forest fragmentation and stream acidification and pollution associated with shale gas development (hydraulic and other anthropogenic activities. Given these associations of the LOWA habitat characteristics and Eastern Hemlock, this species serves as a good model to study the impacts of the HWA invasion. Ways in which LOWA may be impacted by hemlock mortality include habitat selection behavior and individual fitness.

Objectives: The goal of this study was to investigate the impacts of HWA invasion and hemlock decline on LOWA in the southern Appalachians. Specifically, the authors wanted to better understand how birds were selecting habitats based on habitat features related to hemlock condition as well as evaluate how these habitat characteristics were related to individual fitness.

Methods: This study included areas characterized by varying levels of HWA infestation and hemlock condition. Researchers banded and tracked breeding LOWA males during the 2015 and 2016 breeding seasons. They monitored nests throughout the nesting season to determine daily nest survival rate (DSR) and the number of successful nests (i.e., at least one successfully fledged offspring). Several habitat features were measured at points either associated with both LOWA foraging activity and nesting activity as well as randomly selected points representing available areas. The researchers measured 17 habitat features at each point, including canopy cover at 0-1.5 m, 1.5-5 m, 5-15m, and greater than 15 m. Other features measured included availability of woody debris, in-stream exposed rock, exposed live tree roots, hemlock decline, exposed soil, dominant understory vegetation type, stream width, proportion of hemlock, leaf litter, deciduous ground cover, evergreen ground cover, and water. Generalized linear mixed models were used to assess the relationship between these habitat variables and LOWA foraging and nest site selection.

Location: southeastern Tennessee

Findings: Results suggest that, of the habitat features measured, LOWA foraging site selection was associated with higher proportions of woody debris and exposed in-stream rock. Nest site selection was mostly associated with the interaction of the amount of exposed live roots with hemlock condition. Specifically, LOWA appeared to select nest sites with more exposed live roots only when surrounding hemlock condition was poor. Daily nest survival rate was found to be negatively associated with the proportion of deciduous understory, and DSR was higher in sites where conifers dominated the understory. No association was found between adult survival and any of the measured habitat features.

Implications: Information obtained through this study can be used to inform LOWA conservation management in areas that may be vulnerable to HWA invasion, specifically with regards to nest-site selection and daily nest survival rate. Evidence that DSR is positively correlated with the percent of coniferous vegetation in the understory may allow managers to prioritize areas for LOWA breeding based off of this fine-scale habitat characteristic. While hemlock condition is thought to influence the abundance of EPT taxa, it did not influence foraging site selection, suggesting that LOWA may not be as reliant on EPT taxa as previously believed. This evidence adds to other studies that have found similar support for more generalist feeding strategies.

Topics: LOWA, Eastern Hemlock, hemlock wooly adelgid, invasive species control, habitat selection.

Chapman, M., J. R. Courter, P. E. Rothrock, and E. Science. 2015. Riparian Width and Neotropical Avian Species Richness in the Agricultural Midwest. Proceedings of the Indiana Academy of Science 124:80–88.

Background: Declining numbers of neotropical migratory birds in the Midwest are partly driven by agricultural land use practices. Riparian buffers are crucial habitat for many of these species, particularly the LOWA, and understanding optimal buffer width to maximize diversity and abundance is key to avian conservation.

Objective: Here, the authors set out to quantify the minimum riparian buffer area required to support optimal avian diversity and abundance.

Methods: The authors surveyed 36 sites with riparian buffers falling into one of three area categories (< 25 m, 25-75 m, and > 75 m) and conducted three sets of point counts throughout the breeding season in 2013.

Location: Mississinewa River, Grant and Delaware Co., Indiana

Findings: The researchers documented 56 species, 25 of which were neotropical migrants (including LOWA). Within the three riparian buffer area categories, LOWA were most frequently associated with the medium width buffer (25 - 75 m). LOWA were detected on 75% of sites within this medium buffer category. Detections of LOWA were lower on sites with large riparian buffers (> 75 m; detected on 33% of sites) and even lower on small buffer sites (< 25 m; detected on 25% of sites). Logistic regression analysis found a significant positive correlation between buffer width and LOWA presence.

Implications: The LOWA was not the focus of this paper, but rather included in a broader focal group. Despite higher LOWA detection rates within medium riparian buffers over large riparian buffers (75% versus 33% of sites) the significant, positive correlation found with LOWA presence and buffer width echo the general consensus in the literature that this species requires wide riparian buffers.

Topics: agriculture, avian conservation, Midwest, Neotropical migrants, riparian width

Conner, Richard N., Via J. W., P. I. D. 1979. Effects of pine-oak clear-cutting on winter and breeding birds in Southwestern Virginia. Wilson Bulletin 91:301–316.

Background: Clear-cutting is a popular approach to timber harvesting given its economic efficiency. This practice results in even-aged, regenerating stands, having implications for the avian community as different species may be associated with different successional stages of forest re-growth. This study was one of the earlier works investigating the response of the avian community to clear-cutting in the pine-oak forests of southern Virginia.

Objectives: The goal of this study was to assess avian response patterns to regenerating clear-cuts in pitch pine-oak forests and determine if these patterns were similar to those detected in other evergreen forests, or if patterns more closely resembled those of deciduous, oak-hickory clear-cuts.

Methods: The researchers conducted surveys along 100 meter transects in four stages of successional regrowth including 3, 10 and 30-year-old clear-cut stands as well as mature stands. Each of 16 transects were surveyed six times per season (breeding and winter, 1976) and researchers used transect results to calculate relative abundance and Shannon's diversity index.

Locations: Jefferson and George Washington National Forests, southwestern Virginia

Findings: In this study, LOWA were only detected in mature stands, with a relative abundance of 0.013. Overall, avian diversity and species richness increased with stand age during breeding season surveys. This pattern differed from those detected in oak-hickory stands, where young stands 3-12 years old supported highest species diversity and richness.

Implications: Results from this study support the association of LOWA with mature forest stands and have important implications for the effects of timber harvesting in pine-oak forests on avian species diversity and richness.

Topics: pine-oak, clear-cut, timber harvesting, breeding birds, avian species diversity, avian species richness

Conner, R. N., and J. G. Dickson. 1997. Relationships between bird communities and forest age, structure, species composition and fragmentation in the West Gulf Coastal Plain. Texas Journal of Science 49:123–138.

Background: Landscape characteristics such as patch size, fragmentation, edge effect, and landscape use patterns influence avian communities, particularly area-sensitive species such as the LOWA. Forest management and other disturbances in the West Gulf

Coastal Plain region (WCGP) result in changes in these characteristics that lead to predictable shifts in the composition of the avian community. Understanding how specific changes to these associated forest characteristics affect the avian community is crucial to informing avian conservation and management.

Objectives: The aim of the paper was to synthesize and present information demonstrating the relationship between forest characteristics, including successional age, forest structure and composition, fragmentation, and avian community composition within the WGCP region.

Methods: The researchers present information organized by landscape / forest characteristics including forest stand age, forest cover type, vegetation structure, fragmentation, and forest area.

Locations: West Gulf Coastal Plain (WGCP) region

Findings: This paper further supports the dependence of LOWA on large patches of contiguous forest and suggests, based on Robbins et al. (1989), that LOWA only become slightly abundant in tracts of contiguous forest larger than 1,000 ha., where probability of occurrence was less than 0.1.

Implications: This demonstration of the relationship between the LOWA and forest patch size adds to an important body of work supporting the importance of forest area for this area-sensitive species. The authors state that large, contiguous tracts of mature forests should be prioritized to implement effective conservation of forest area-sensitive species, such as LOWA.

Topics: avian community, West Gulf Coastal Plain, forest area, forest fragmentation, edge effects, area-sensitive species

Craig, R. J. 1984. Comparative Foraging Ecology of Louisiana and Northern Waterthrushes. The Wilson Bulletin 96:173–183. <https://www.jstor.org/stable/4161910%0AJSTOR>.

Background: The possibility for sympatric populations of closely related species often requires evolutionary divergence in certain traits and behaviors to reduce interspecific competition. Interspecific differences that may reduce interspecific competition include modifications to foraging behaviors, such as foraging zone, foraging method, and size and type of prey. Previous researchers suggested that these interspecific differences alone may not account for sympatry, and that selection may not be strong enough in variable environments to drive divergence in traits. Others, however, suggest that character divergence in species with high niche overlap that demonstrate low levels of interspecific competition may be driven by periods of low resource availability in a variable environment.

Objective: The goal of this study was to determine the level of inter-specific competition between sympatric populations of the closely related Louisiana and Northern waterthrushes.

Methods: The researcher observed territoriality and foraging behaviors of banded Louisiana and Northern Waterthrushes during the breeding seasons of 1978-1980, recording habitat used (water, ground, foliage, and air), foraging method (picking, leaf-pulling, hawking, and hovering), and foraging frequency. The researcher also sampled aquatic invertebrates to estimate the composition of available prey species within each species' territory.

Location: Ashford Tolland, Connecticut

Findings: This study suggested high overlap in foraging behaviors of the Louisiana and Northern Waterthrushes. Territory size differences between the Louisiana and Northern Waterthrushes were not significant. Observed individuals exhibited little interspecific territoriality, although territories frequently overlapped. Prey searching behavior was similar between the two species. Picking and leaf-pulling were the most employed foraging methods in both water and ground foraging. Foraging behavior did not differ between species prior to leaf emergence. After leaf emergence, Northern Waterthrush spent more time foraging in foliage, whereas the LOWA remained closely tied to ground and water foraging. Prey taken by the LOWA mostly consisted of isopods, gastropods, Ephemeroptera nymphs, and larvae of Trichoptera, Culicidae, and Dysticidae. LOWA's preferred territories with a higher abundance of Trichopterans than Northern Waterthrushes. Territories of LOWA's also had a higher biomass of invertebrates greater than 13 millimeters in length, although no statistical difference was found in the overall invertebrate biomass between territories of the two species. Results suggested that both species require invertebrates of various sizes.

Implications: The lack of territoriality, along with the similarity in foraging behaviors (site and method) suggest that interspecific competition is weak, and therefore unlikely to be responsible for the evolutionary divergence of these two closely related species.

Topics: interspecific competition, avian foraging behavior, LOWA, Northern Waterthrush

Dickson, J. G., F. R. Thompson, R. N. Conner, and K. E. Franzreb. 1999. Effects of silviculture on neotropical migratory birds in central and southeastern oak-pine forests. NCASI Technical Bulletin 134–135.

Background: Silviculture practices can have profound impacts on species with specific habitat requirements, like the LOWA, while other species may benefit from such land use patterns.

Objectives: The aim of this paper was to synthesize and present information on the relationship between avian community patterns and silviculture practices in different forest types, including central hardwood, loblolly-shortleaf, longleaf-slash pine, and bottomland hardwood forests.

Methods: This paper presents landscape level impacts of forest stage and management in loblolly shortleaf pine, longleaf-slash pine, and bottomland hardwood (oak-gum-cypress)
forests on the neotropical migratory bird community. Stand ages included first year regeneration stands, sapling stands (10 - 20 years, pole timber stands (20 - 60 years), and mature stands. Management strategies including group selection and single tree selection were also considered.

Locations: southeastern United States

Findings: While this work included many focal species, with regards to the LOWA, this work demonstrated that, in central hardwood forests, LOWA are only present in pole timber and mature stands, or mature stands undergoing group and single-tree selection silviculture. In even-aged loblolly-shortleaf pine stands, LOWA are only present in mature (35 - 50 years) and old growth (> 50 years0 stands). Referencing Hamel et al. (1982), this paper shows that LOWA are regular inhabitants of oak-gum-cypress forests in the southeast.

Implications: This paper presents further support that habitat requirements for the LOWA include mature forest stands in the southeast, particularly in central hardwood or loblolly-shortleaf pine stands, while also reinforcing the association of the LOWA with bottomland hardwood forests in the southeastern United States.

Topics: silviculture, central hardwood forest, loblolly-shortleaf pine forest, longleaf-slash pine forest, bottomland hardwood forest, oak-gum-cypress, breeding birds, timber management

Eaton, S. W. 1958. A life history study of the LOWA. Wilson Bulletin1 70:210–235.

Background: This descriptive study is an important early work highlighting various components to LOWA natural and life histories.

Objectives: The goal of this study was to observe LOWA over both breeding and wintering
seasons and document biologically meaningful behaviors and characteristics.

Methods: The researcher observed a total of 16 nests during the breeding seasons of 1947, 1948, and 1949, and 7 non-breeding individuals during winters of 1948 and 1949. Among the characteristics documented were variation in plumage (seasonal and age), breeding ground arrival times (males and females), territory size and territoriality, song features, habitat features, nest features, incubation, nestling features, fledgling features, food (breeding and winter), parasitism, fat deposition, weight, molt, and exoparasites.

Location: Ithaca, New York and Cienfuegos, Cuba

Findings: This work highlights key characteristics that have been repeatedly associated with LOWA breeding habitat. LOWA were determined to occupy roughly 400 meters of stream. During the early breeding season, foraging occurred entirely in the stream, where LOWA flip leaves and other debris searching for aquatic macroinvertebrates. As the season progressed, LOWA utilized the terrestrial areas of their territory for foraging as well. LOWA were observed to appear most comfortable on bare, flat rocks of the stream and glen floors. Nests were constructed from material generally within 30 meters of the nest. Most nests were positioned on the south side of the ravine, between 0.5 and 4.0 meters above the ground. Nest construction observed during this study typically consisted of individuals digging cups in the exposed dirt of streambank and filling this with leaves from adjacent areas within the stream and on land. Nests included leaves from oak, elm, and maple trees species. Fledglings were observed dispersing up 4.8 kilometers one-month post-fledging. Within the study area, small streams dried up towards mid-July and birds were found foraging on land along the stream or shore. Nestling diet from samples included gastropods, coleoptera (adults), and other unidentified fragments. Adult diets included chironomid (e.g., midges) larvae, dipterid (flies) larvae, and coleopterid (beetles) adults. While Plecoptera (stoneflies) and Ephemeroptera (mayflies) were only identified in the stomach contents of one individual, LOWA were observed to favor these insects (nymphs just before hatching and slow flying adults after hatching). Brown-headed cowbirds parasitized 56% of the 16 nests observed. During this study, 70% of 60 LOWA eggs successfully fledged.

Implications: This study represents one of the first to thoroughly document these natural and life history traits for the LOWA, informing many future studies and guiding conservation management for this species.

Topics: LOWA, life history, natural history, Ithaca, Cayuga Lake

Farwell, L. S., P. B. Wood, D. J. Brown, and J. Sheehan. 2019. Proximity to unconventional shale gas infrastructure alters breeding bird abundance and distribution. Gerontologist 59:1–20.

Background: In the central Appalachian region, shale gas development is rapidly driving forest disturbance and fragmentation, having potential impacts on populations of breeding birds.

Objectives: The aim of this study was to determine the relationship between the abundance of songbirds and proximity to shale gas development and infrastructure.

Methods: The researchers assessed the response of 27 species representing forest interior, early successional, and synanthropic species, to shale gas development. To quantify proximity to shale gas development and infrastructure, the researchers generated and used a land classification map including forest, timber harvest, shale gas development and associated infrastructure. Point count surveys were conducted at 142 survey stations separated by ≥ 250 meters during the breeding seasons of 2008-2017. Generalized linear mixed models were used to relate species abundances with distance to shale gas development.

Locations: Lewis Wetzel Wildlife Management Area, West Virginia

Findings: Over 50% of the species assessed in this study responded negatively to proximity to shale gas development or infrastructure (e.g., roads, well pads). While not significant, LOWA abundance was negatively associated with shale gas well pads and linear gas infrastructure (e.g., roads).

Implications: The negative association with LOWA abundance and proximity to shale gas development is crucial given that fracking has been increasing in many parts of the LOWAs range. This study is a step towards better understanding how shale gas development impacts the LOWA.

Topics: Appalachians, avian guilds, energy development, forest songbirds, hydraulic fracturing, land-use change, Marcellus-Utica, unconventional shale gas

Frantz, M. W., P. B. Wood, S. C. Latta, and A. B. Welsh. 2020. Epigenetic response of LOWA Parkesia motacilla to shale gas development. Ibis 162:1211–1224.

Background: Shale gas development imposes environment stressors throughout riparian
ecosystems, such as the accumulation of heavy metals such as barium (Ba) and strontium (Sr) within the food chain. An obligate riparian songbird, the LOWA is vulnerable to shale gas development and resultant environmental stressors. DNA methylation is an epigenetic mechanism that could potentially result from environmental signals (such as the presence of heavy metals such as Ba and Sr) that can modify gene expression in wild bird populations. Given that the LOWA is a top predator, bioaccumulation of heavy metals such as Ba and Sr may occur where streams are within close proximity to shale gas development.

Objectives: The goal of this study was to analyze patterns of DNA methylation across sex and age, as well as correlate DNA methylated sites in LOWA with concentrations of Ba and Sr in feathers and assess the influence of shale gas development on DNA methylation.

Methods: The researchers captured, banded and monitored 146 individuals and 159 nestlings during 2013-2015, collecting blood samples via brachial venipuncture for epigenetic analysis. Annual shale gas disturbance was digitized for the study area so that each LOWA territory could be classified as disturbed or undisturbed. Two derived variables included "TerrGas" (shale gas disturbance within 60 m of stream centerline) and "TerrRunoff" (presence or absence of potentially contaminated shale gas runoff from upstream sources). Analysis of molecular variance (AMOVA) was used to describe overall methylation variation by sex, age, and shale gas disturbance.

Locations: Lewis Wetzel Wildlife Management Area, West Virginia

Findings: Results from this study suggested variation in methylation patterns between males and females (fewer methylated sites in males). The researchers also observed an overall decrease in methylated sites with age. Males in territories classified as disturbed had fewer methylated sites than those in undisturbed sites. Furthermore, feather analysis of Ba and Sr concentrations showed that adult males experienced a negative correlation with methylated sites and concentrations of these heavy metals. Adult females, however, showed a positive correlation between Sr concentrations and methylation. No correlation was detected in nestling feathers.

Implications: The results of this study link shale gas disturbance with sex and age specific
patterns in DNA methylation and gene expression in the LOWA. Such modifications to gene expression could potentially have harmful impacts on reproductive fitness and, as a result, long-term population trends.

Topics: bioindicator, contaminants, DNA methylation, Marcellus-Utica, shale gas

Frantz, M. W., P. B. Wood, and G. T. Merovich. 2018a. Demographic characteristics of an avian predator, LOWA (Parkesia motacilla), in response to its aquatic prey in a Central Appalachian USA watershed impacted by shale gas development. PLoS ONE 13:1–19.

Background: Shale gas development, or fracking, in the central Appalachians has increased over recent years, having disproportionate impacts on forested habitats and often occurring within close proximity to streams. Aside from forest loss and fragmentation, impacts from shale gas activity include increased concentrations of sediments and contaminants. The LOWA is a riparian obligate songbird with a foraging behavior that depends largely on pollutant-intolerant benthic macroinvertebrates, such as taxa from the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT taxa) and, as such, is particularly vulnerable to shale gas related disturbance. Previous studies have identified a positive relationship between LOWA reproductive success and habitat quality as it relates to shale gas development.

Objectives: As a follow up to previous studies, the researchers aimed to assess the usefulness of assessing the aquatic prey community along with riparian habitat quality indices in predicting LOWA habitat quality. This study also sought to determine the potential for shale gas associated runoff to influence changes in aquatic prey communities within LOWA territories, as well as quantify the demographic response of LOWA to these changes.

Methods: The researchers used aerial photography to map shale gas related disturbance within the study area and assessed riparian habitat quality using the Prosser and Brooks LOWA HSI along with the U.S. EPA Rapid Bioassessment Protocol for high gradient streams. LOWA were monitored and territory length, density, and nest survival (including daily nest survival rate or DSR) were quantified for 14 stream reaches in 2011, 2013, and 2014. Benthic macroinvertebrates were sampled from in-stream riffle habitats at 178 nests sites shortly after either the nestlings fledged, the nest was abandoned, or the nest failed. Two metrics were used to quantify aquatic prey composition including the West Virginia Stream Condition Index (WVSCI) and the Genus Level Index of Most Probable Stream Status (GLIMPSS). The researchers used spatial generalized linear mixed models (SGLMMs) to determine relationships between LOWA demographic characteristics, benthic macroinvertebrate community, and riparian habitat quality.

Locations: Lewis Wetzel Wildlife Management Area, West Virginia

Findings: The results of this study varied over years, but collectively suggest a threshold of shale gas activity at which LOWA respond negatively to changes in prey communities. Shale gas disturbance decreased from 2011 to 2013 and then increased from 2013 to 2014. In 2011, researchers found a significant negative correlation between GLIMPSS, EPT richness and abundance of pollutant-intolerant genera with LOWA territory length, where territory length increased with lower prey availability. Macroinvertebrate community biomass and density showed a positive response to increasing EPA habitat assessment score in 2013. In 2014, researchers observed a higher proportion of pollutant intolerant taxa with increasing EPA and HSI scores. Researchers also observed smaller LOWA territories with increasing density of aquatic prey in 2013. In 2014, however LOWA territory size increased despite increased EPT richness. No significant relationship was found between clutch size, number of fledglings, and territory density with prey metrics. The best supported model suggested that rain positively influenced DSR in both 2013 and 2014. Shale gas runoff was shown to negatively influence DSR in 2014.

Implications: The variable results presented in this study suggest that there is likely a threshold of shale gas activity to which the aquatic prey community, and subsequently LOWA, respond negatively. This paper suggests that the disassociation between territory length and aquatic prey density in 2014 may have resulted from the LOWAs ability to expand their foraging niche to include parts of the territory undisturbed by shale gas activity and runoff. Collectively, this work presents important evidence highlighting the potential impacts of shale gas development on LOWA reproductive success (e.g., shale gas runoff negatively impacted DSR) having important implications for the conservation of this species.

Topics: shale gas developments, LOWA, habitat suitability, EPT, demography,

Frantz, M. W., P. B. Wood, J. Sheehan, and G. George. 2018b. Demographic response of LOWA, a stream obligate songbird of conservation concern, to shale gas development. Condor 120:265–282.

Background: Rates of shale gas development have been increasing in the eastern United States having potentially detrimental effects on breeding populations of the stream obligate songbird, the LOWA. Regions of highest LOWA abundance co-occur with the Marcellus shale region which is undergoing rapid shale gas development. Disturbances associated with shale gas include core forest disturbance and contamination of stream water.

Objectives: The goal of this study was to assess the influence of shale gas development on the LOWA breeding population.

Methods: The researchers assessed LOWA demographic response to shale gas development during the breeding seasons of 2009-2011 and 2013-2015 by monitoring 58.1 km of first and second order forested streams. Over the study period they monitored 400 LOWA territories. Riparian habitat quality was assessed with a previously established LOWA Habitat Suitability Index (HSI) and the United States Environmental Protection Agency (EPA) rapid bioassessment for high gradient streams. Images from the National Agriculture Imagery Program (NAIP) were used to detect and classify shale gas related forest disturbance. Other variables included streamside gas disturbance, run-off potential, proportion of LOWA territories disturbed by gas, and run-off potential in each territory. To quantify nest survival and productivity the researchers estimated LOWA nest daily survival rate (DSR). Nests that fledged at least one offspring were considered successful. This study also compared nest success with adult mortality rate to characterize habitats as sink or source.

Location: Lewis-Wetzel Wildlife Management Area, West Virginia

Findings: This study found overall declines in LOWA territory density, nest survival, productivity, and habitat quality that correlated with increased shale gas related disturbances. The source-sink threshold suggested that areas disturbed by shale gas development are habitat sinks, and populations breeding in these areas may be vulnerable.

Implications: This study highlights the threat that shale gas development poses to breeding populations of LOWA. Significant relationships between LOWA demographic variables and gas disturbance related variables may enable future research to incorporate these variables into models predicting LOWA habitat suitability and riparian ecosystem health.

Topics: LOWA, shale gas development, demographic response, bioindicator species, riparian ecosystem health

Frantz, M. W., P. B. Wood, J. Sheehan, and G. George. 2019. LOWA (*Parkesia motacilla*) survival and site fidelity in an area undergoing shale gas development. Wilson Journal of Ornithology 131:84–95.

Background: Shale gas development (hydraulic fracturing, or "fracking") impacts many of the riparian habitats that species, such as the stream-obligate LOWA, depend on. Much of the LOWAs breeding range overlaps with one of the largest shale gas beds in the country - the Marcellus-Utica shale region. Fracking and the resultant acidification is known to negatively affect the stream benthic macroinvertebrate communities, which provide a critical food source for breeding LOWA. This decrease in habitat quality associated with fracking may result in a decrease in site fidelity, which is typically high in LOWA, as birds search for more optimal breeding habitat.

Objectives: The goal of this study was to quantify rates of breeding site fidelity, assess habitat features that might influence annual return rates, and estimate annual survival across streams associated with various degrees of shale gas activity.

Methods: The researchers monitored LOWA on 14 first and second order streams. Aerial photography was used to map shale gas disturbances throughout the study area. A stream was classified as disturbed if any fracking infrastructure was within 60 meters of the stream. LOWA territories were mapped each year along stream reaches. For each stream and territory, they calculated proportion disturbed by shale gas and the potential for runoff. LOWA were banded during 2009-2011, and 2013-2015. Territories and nests were monitored for return rates, daily nest survival, adult survival, and breeding success. The Prosser and Brooks 1998 HSI was used to quantify riparian habitat at each LOWA nest.

Locations: Lewis Wetzel Wildlife Management Area, West Virginia

Findings: Site fidelity declined in both males and females from an initial rate of 63% in 2009-2010, to 32% in 2015. Three factors that were associated with site fidelity in males included an increased proportion of shale gas disturbance, lower EPA rapid bioassessment for high gradient streams scores, and lower HSI scores. Among females, this study showed that site fidelity decreased with the number of previous breeding attempts. Given the overall decline in site fidelity, the increase in shale gas activity, and positive relationship found between male site fidelity and proportion of territory disturbed by shale gas activity, it is unclear if the increased rates of fidelity among males was due to fracking.

Implications: While this study demonstrated that LOWA return rates were relatively high on shale gas disturbed territories with lower habitat suitability, collective research suggests that these impacted territories may serve as population sinks. Previous research conducted by the author and colleagues linked lower breeding productivity with shale gas disturbance meaning continued site fidelity in these impacted habitats could have negative impacts on the LOWA population long-term. As such these habitats could represent ecological traps.

Topics: bioindicator, source-sink, headwater stream, Marcellus-Utica, site fidelity

Hamel, P. B. 1992. The land managers guide to the birds of the south. The Nature Conservancy, Chapel Hill, NC.

Background: This guide serves as a reference for how birds in the Southeastern U.S. use
available forested habitats, providing a synthesis of the status, distribution, and habitat requirements for each species, including the LOWA.

Objectives: The purpose of this book is to assist land managers in implementing sound and effective management practices.

Methods: This body of work was developed from unpublished reports prepared for the Southeastern region by the United States Forest Service.

Locations: southeastern United States

Findings: In this guide, Hamel describes key habitat requirements for the LOWA to generally include forested, rocky streams. Estimates of breeding densities are provided for four different habitat categories with the highest densities in the southeast region predicted for saw timber oak-gum-cypress, followed by saw timber mixed pine-hardwood, saw timber oak-hickory, and pole timber elm-ash-cottonwood.

Implications: This guide has been cited by many publications describing LOWA breeding habitat and highlights the association of LOWA with mature forests, particularly oak-gum-cypress within the southeast region while also suggesting that 100% deciduous forest provides sub-optimal habitat relative to mixed deciduous / coniferous forest composition.

Topics: LOWA, habitat relationships, forest management

Hayden, T. J., J. Faaborg, and R. L. Clawson. 1985. Estimates of minimum area requirements for Missouri forest birds. Transactions of the Missouri Academy of Science 19:11–22.

Background: Two important concepts for conservation of birds include the relationship between community composition and diversity with habitat area, and the dependence many species have, such as the LOWA, on habitat area. Understanding which species are limited by habitat area and their area requirements is crucial for effective conservation of long-term, sustainable populations.

Objectives: The purpose of this study was to identify birds with habitat area requirements within the study area and estimate the minimum areas required to sustain long-term, viable populations.

Methods: The researchers identified breeding birds within 15 upland oak-hickory dominated forest sites in 1983 and 1984. Forest patch sizes ranged from 1.2 ha to over 1000 ha, broken up into four classes (1.2-2.2, 4.6-14.9, 42.2-53.6, and >340 ha). Statistical analysis was used to determine if species occurrence was independent of forest area class.

Locations: Boone, Callaway, Audrain Co. Missouri

Findings: This study confirmed that LOWA occupancy is dependent on forest area. LOWA did not occur in any forest patch smaller than 42.2 ha. Most were only found in tracts larger than 341 ha. Percent of occurrence for LOWA was low in this study (15%) which is to be expected given this study focused on upland hardwood while the LOWA is typically associated with bottomland forest.

Implications: This study presents a potential minim forest area requirement for the LOWA, at least for those breeding in the upland forests of Missouri. This minimum value is referenced in the 2009 HSI developed for LOWA by Tirpak et al. as unsuitable habitat. That LOWA were typically only found on forest patches greater than 341 ha supports other previous work suggesting that at least 350 ha of forest will provide suboptimal LOWA habitat.

Topics: birds, habitat requirements, island biogeography, nongame management

Hyder, S.N. 2002. Investigation of the relationship between floodplain geomorphology and riparian songbird communities. University of Georgia.

Background: Riparian habitats support a diverse community of songbirds. Different geomorphological features associated with riparian ecosystems may influence the surrounding riparian community. Understanding how these habitat features might impact avian communities is crucial given high rates of anthropogenic induced change.

Objectives: The goal of this thesis was to assess relationships between geomorphological
characteristics of streams and valleys with riparian songbird communities.

Methods: The researchers surveyed 40 sites including naturally forested riparian habitats, buffered riparian habitats (adjacent timber harvesting) and beaver swamps during spring of 2000 and 2001. Quantified geomorphological variables included in-stream habitat type (pool, riffle, and run), length, width, and depth of each habitat unit, width to depth ratio of the channel, substrate composition (sand, silt, or clay), woody debris, bank slope, median particle size, and percent canopy cover. Floodplain width was estimated, and total buffer width measured on sites where timber harvesting occurred. The researchers also conducted vegetation surveys including percent ground cover. Mean abundance and species richness were calculated from songbird surveys conducted along streams. Species richness and abundance were compared across forested sites (no timber harvesting), buffered sites, and beaver swamps.

Locations: Piedmont region, Georgia

Findings: Positive correlations were detected between LOWA presence and increased channel slope, low canopy cover, and higher percent riffle, although these relationships were not statistically significant. Significant differences in LOWA abundance were found between forested vs. buffered, forested vs. beaver, and buffered vs. beaver habitats. LOWA abundance was highest in undisturbed forested riparian habitats, followed by buffered riparian habitats. LOWA were absent from beaver swamp habitats.

Implications: The association of LOWA abundance with low canopy cover was insignificant and inconsistent with the larger body of literature highlighting LOWA habitat requirements. As such, this relationship should be considered with caution. Other correlations, although not significant, were consistent with known LOWA habitat requirements, such as high proportion of riffles and a preference for high to moderate gradient streams.

Topics: LOWA, riparian habitats, geomorphology, breeding habitat, bottomland hardwood forest

Jorgensen, J.G., Dinan, L.R., Brogie, M.A., Silcock, J.R., Klaphake, C., and Steinauer, G. 2014. Breeding bird diversity, abundance, and density at Indian Cave and Ponca State parks, Nebraska, 2012-2014. University of Nebraska, Nebraska Game and Parks Commission.

Background: In the Midwest, changes in fire regimes are affecting deciduous oak forests and woodlands and species within. Fire may impact many understory and ground nesting bird species. While the impacts are negative for some species, fire may benefit others.

Objectives: The aim of the study was to initiate a long-term avian species monitoring program and compare diversity and community composition between burned and unburned management units in two sites within the study area.

Methods: The researchers conducted surveys during late Spring of 2012, 2013, and 2014.
Results of transect surveys were used to calculate avian diversity, community similarity, and relative abundance across sites. The Shannon-Weiner Diversity index was used to calculate avian diversity across study sites and Jaccard's index was used to measure community similarity across sites.

Locations: northeastern Nebraska

Findings: In this study, LOWA were only found in burned sites. LOWA were absent from unburned study plots.

Implications: This results from this study provide important insight on the response of LOWA to burn practices. The absence of LOWA from unburned plots suggests that this particular fire regime, and an open understory with a diverse ground cover plant community, may provide better habitat than plots experiencing no fire. This study provides baseline data to continue monitoring species within the study site and document long-term response of the avian community to burn practices.

Topics: Fire management, avian diversity, breeding birds, Nebraska

Kilgo, J. 2018. Effect of Stand Width and Adjacent Habitat on Breeding Bird Communities in Bottomland Hardwoods. Wiley on behalf of the Wildlife Society Stable URL : h. 62:72–83.

Background: Bottomland hardwood forests have been subject to disturbance and are declining in area, largely due to timber demands. The loss of available bottomland hardwood habitat may have negative impacts on avian communities, particularly area-sensitive species such as the LOWA. In addition to forest area, however, riparian buffer width is suggested to be influential for the avian community. Understanding how species respond to differences in riparian buffer width is an important element to forest management.

Objective: This study sought to assess avian abundance and richness across riparian buffers ranging from less than 50 to over 100 meters in width.

Methods: Surveys were conducted during the breeding seasons of 1993-1995 in stands classified as < 50m, 50 - 150 m, 150 - 300 m, 300 - 1,000 m, and > 1,000 m. Habitat characteristics measured included canopy cover, vegetation profile, tree species and size, and basal area of hardwood pole and saw timber. Bird populations in each stand were sampled using point counts. The effect of stand width and habitat variables on species richness was assessed using a generalized linear model (GLM).

Locations: western and central South Carolina

Findings: In this study, probability of detecting LOWA was highest in narrow riparian buffers 25 meters wide (probability of detection = 0.44). Probability of LOWA detection decreased as riparian buffer width increased.

Implications: This study demonstrates that even small riparian buffers up 25 meters wide may be important to LOWA conservation, despite the area-sensitivity of this species.

Topics: bottomland hardwoods, breeding birds, landscape management, minimum area requirement, South Carolina, species richness

Knutson, M.G., Hoover, J.P., and Klaas, E.E.1995. The importance of floodplain forests in the conservation and management of neotropical migratory birds in the Midwest. In Management of midwestern landscapes for the conservation of neotropical migratory birds.U.S. Department of Agriculture, U.S. Forest Service, North Central Forest Experimental Station. 198.

Background: Avian communities differ between floodplain forests and upland forests of the central Midwest. Threats facing both floodplain forests and upland forests include, most prominently, forest loss. Given the high abundance of some species within floodplains, as well as documented increased nesting success, conservation efforts should focus on maintaining large, contiguous tracts of both floodplain and associated upland forests along with the restoration of previously degraded habitats.

Objectives: The goal of this paper was to present information on the dynamics and structure of floodplain forests in the Midwest, the floodplain forest bird community, potential threats to floodplain-nesting birds, as well as floodplain management and conservation.

Methods: The author organized this work via an extensive literature review, describing each component, including the dynamics and structure of floodplains in the Midwest, the avian community (migration, dispersal and breeding), threats and management concerns. A case study is presented to describe differences in the floodplain vs. upland forest bird communities. Researchers used point counts to establish presence of avian species and calculate relative abundance for each species. Researchers also located and monitored nests to determine nesting success.

Locations: southern Illinois

Findings: Information provided in this work regarding the LOWA highlight an affiliation of this species with upland and floodplain forests within the Midwest. Findings from the comprehensive review suggest that LOWA were more abundant in upland forests than in floodplain forests (relative abundance = 0.56 and 0.38, respectively). Results from the case study also supported a preference of the LOWA for upland forest over floodplains in the Midwest when researchers failed to detect LOWA in floodplain forests.

Implications: This review and case study suggests that forest type preferences for the LOWA varies, and may include both upland and floodplain forests, with a tendency towards upland forests within the Midwest region.

Topics: floodplain forest, upland forest, avian community, forest loss

Latta, K. 2009. What determines success? Breeding habitat characteristics of the LOWA (*Seirus motacilla*). 1–15.

Background: The LOWA, the only stream-obligate songbird bird in the Eastern United States, is considered an important bioindicator species given its dependence on healthy stream quality and the presence of macroinvertebrates, specifically, species of the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) – which are particularly sensitive to environmental changes in stream chemistry. LOWA occurrence in a riparian habitat is positively correlated with the abundance of EPT taxa and, therefore, suggests high stream quality. Understanding the factors contributing to LOWA breeding success in riparian habitats will allow researchers to better predict LOWA occurrence, and, therefore, stream-quality.

Objectives: The goal of this study was to assess the relationship between several ecological variables in LOWA breeding territories with reproductive success.

Methods: Researchers located LOWA nests during the 2007 breeding season and collected the following data: bank type, bank height, bank orientation, nest cup visibility, distance of nest to the stream, and dominant vegetation type. Individual LOWA were banded, and nesting success monitored throughout the breeding season to determine nest success.

Location: Pittsburgh, Pennsylvania

Findings: LOWA territories assessed in this study were, on average, roughly 50,000 m2, along an average stream length of roughly 7,000 m. Streams in LOWA territories were characterized by riffles, runs, and pools. Territories with fledgling success had a higher proportion of canopy cover and oak trees than territories where fledging was unsuccessful, which had a higher proportion of poplar trees. This study also showed that territories where fledging was unsuccessful consisted of a higher percentage of intermittent streams than territories where fledging was successful. Canopy cover and poplar tree density were statistically significant in their ability to predict fledging success.

Implications: This study showed that, within the study area, LOWA has higher reproductive success in riparian habitats with greater canopy cover and perennial streams, highlighting two potentially valuable predictor variables to assess habitat suitability for the LOWA.

Topics: bioindicator, nesting success, LOWA, habitat quality,

Latta, S. C., L. C. Marshall, M. W. Frantz, and J. D. Toms. 2015. Evidence from two shale regions that a riparian songbird accumulates metals associated with hydraulic fracturing. Ecosphere 6.

Background: Hydraulic fracturing, or fracking, poses environmental risks associated with forest disturbance and the erosion and sedimentation of waterways. Contamination of surface waters and streams occurs throughout parts of the fracking process, and it's unknown to what degree these contaminants are infiltrating the riparian food chain. The LOWA is a top predator of aquatic prey in first and second order streams and are subject to bioaccumulation of chemical contaminants. This status as a top predator, along with its association with high quality streams, makes the LOWA a good bioindicator with which researchers can investigate the impacts of shale gas fracking on riparian and terrestrial systems.

Objectives: The goal of this study was to investigate the accumulation of two chemical contaminants associated with shale gas development: barium (Ba) and strontium (Sr) in riparian systems using the LOWA as a bioindicator species.

Methods: The study took place from 2010 to 2013, during which researchers sampled 285 LOWA feather samples for presence of Ba or Sr. Evidence of bioaccumulation was compared between study sites associated with fracking and sites where no fracking had occurred.

Location: Lewes Wetzel Wildlife Management Area, northwestern West Virginia, Westmoreland Co. Pennsylvania, Van Buren, Conway, and Faulkner counties, Arkansas

Findings: The results from this study revealed significantly higher concentrations of both Ba and Sr in LOWA feathers collected on fracked sites that those collected on non-fracked sites.

Implications: This study helps to highlight the potential impact of shale gas development on riparian habitats by revealing that the LOWA is bioaccumulating associated chemicals in affected regions.

Topics: bioindicator, contamination, LOWA

Loman, Z. G., W. V. Deluca, D. J. Harrison, C. S. Loftin, B. W. Rolek, and P. B. Wood. 2018. Landscape capability models as a tool to predict fine-scale forest bird occupancy and abundance. Landscape Ecology 33:77–91. Springer Netherlands.

Background: Landscape Capability models are an important tool for predicting current and future habitat distributions that can be implemented in conservation planning.

Objectives: The goal of this study was to evaluate a set of Landscape Capability (LC) models and test their ability to predict occupancy and abundance for seven bird species associated with spruce-fir, mixed conifer-hardwood, riparian, and wooded wetland habitats, including the LOWA, which was included to represent hardwood or mixed-hardwood forest types.

Methods: A validation set was generated using point count data from previous monitoring efforts and used to test the accuracy of the models.

Location: northeastern U.S.

Findings: LOWA detection points were primarily in the Appalachian Landscape Conservation Cooperative (LCC) region. The model performed well at explaining variation in LOWA occupancy. LOWA occupancy was better predicted by smaller buffer width (100 m), as opposed to large buffers ranging from 1 - 500 km. Most LOWA detections occurred in northern hardwood conifer and central oak-pine forests.

Implications: Results from this suggest that the LC performed best at explaining LOWA occupancy at a small scale of 100 m buffer width. The accuracy of the LC demonstrated here imply that this model may be a useful tool for LOWA conservation in the northeastern U.S.

Topics: Appalachians, Breeding Bird Survey, distance sampling, Landscape Conservation
Cooperatives, North Atlantic, Point Counts, Removal sampling, validation, verification

Marshall, L. C. 2012. Territories, territoriality, and conservation of the LOWA and its habitat, the watershed of the upper Buffalo National River. University of Arkansas: 1–223.

Background: The presence or absence of the LOWA has long been considered an indicator of stream water quality due to their dependence on pollutant-sensitive aquatic macroinvertebrates, particular from the order Ephemeroptera, Plecoptera, and Trichoptera (EPT taxa). These aquatic organisms are vulnerable to changes in land-use and the resultant impact on stream water quality through increased run-off pollution and sedimentation. There are various studies at the local scale that provide evidence to support this relationship between LOWA, EPT availability and abundance, and stream water quality, suggesting that LOWA breeding density and success is positively influenced by an abundance of EPT prey sources and circumneutral stream quality. The Buffalo National River watershed is experiencing extensive conversion of forest to agriculture. Given that only a small percentage of the riparian habitats associated with this watershed fall under federal protection, it is likely that anthropogenic activity is impacting the water quality and possibly the ability of the landscape to support LOWA breeding populations.

Objectives: In this study, the researcher set out to map and monitor LOWA territories on both federally protected and unprotected reaches of stream adjacent to anthropogenic activity and define a functional relationship between LOWA territory length and riparian habitat quality.

Methods: The researchers located 219 LOWAs on 23 territories from 2005-2008, monitoring nests every three days. For each territory they measured percent canopy cover and several variables associated with macroinvertebrate community composition including family biotic index (FBI), EPT richness, percent dominant taxa of EPT, gastropoda, and Chironomidae. Macroinvertebrates were sampled to mimic leaf-pulling foraging maneuvers both prior to and following several flooding events so that the researchers could assess any potential changes to the invertebrate community that may result from high water events. Tests for significance included two-factorial ANOVA and multiple regression techniques.

Locations: Buffalo National River watershed, northern Arkansas

Findings: Protected and unprotected stream reaches differed significantly in several bioassessment metrics, including a higher percent of pollutant tolerant taxa (including Chironomidae larvae) and a lower percent of pollutant intolerant taxa (Plecoptera and Trichoptera) in unprotected stream segments. FBI values also indicate higher levels of organic pollutants in unprotected versus protected stream reaches. Territories on unprotected stream reaches were significantly longer than those on protected reaches. While there was no significant difference in canopy cover between territories based on legal protection status, results do suggest that percent canopy cover is more variable on unprotected territories than protected territories. Percent canopy cover was significant in predicting an increase in territory size with decreasing canopy cover. No significant difference was found in nest success and site fidelity across protected and unprotected streams.

Implications: The findings reported in this study echo previous work highlighting the association of LOWA with high-quality riparian habitats, in particular the percent of Plecoptera and Trichoptera taxa, further supporting the use of LOWA as a biological indicator of stream quality. The association between percent canopy cover and territory length can be used to assess habitat suitability for the LOWA across a gradient of canopy cover.

Topics: LOWA, stream ecological assessment, riparian songbird, aquatic invertebrate prey, bioassessment

Mason, J., C. Moorman, G. Hess, and K. Sinclair. 2007. Designing suburban greenways to provide habitat for forest-breeding birds. Landscape and Urban Planning 80:153–164.

Background: Avian diversity has been shown to decrease in response to human development. In a suburban landscape, forest corridors and greenways can help mitigate the negative effects of development and suburbanization, providing important habitat for birds, particularly forest-interior species that are sensitive to anthropogenic disturbance. Greenway effectiveness is influenced by several factors including within-greenway habitat quality, greenway width, and adjacent land use cover.

Objectives: The goal of this study was to estimate how within-greenway forest corridor width, vegetation structure, and adjacent land use and cover impact the avian community and ultimately provide guidance on the design and management of effective urban greenways for avian species sensitive development.

Methods: Using a point-count sampling technique, the researchers conducted surveys during spring of 2002 and 2003 on 34 forested segments of greenway. Forested corridor widths ranged from 32.5 meters to 1300 meters (mean - 207.57 meters). Land cover was determined with aerial imagery. Greenway vegetation composition and structure was measured as percentage of mature forest, young forest, managed area, and stream within a 50 m radius. The researchers also measured percent canopy cover, canopy height, percent pine and hardwood, percent vine cover, percent shrub cover, and percent ground cover. Total avian species richness and abundance was calculated for each greenway segment as well as within-guild species richness and abundance.

Locations: Raleigh and Cary, North Carolina

Findings: One of 53 species detected in this study, LOWA were only recorded in greenways wider than 300 meters.

Implications: These findings are consistent with LOWA being a forest area-sensitive species.

Topics: breeding birds, corridor width, forested greenways, urban planning

Mattsson, B. J., and R. J. Cooper. 2006. Louisiana Watherthrush (*Seiurus motacilla*) and habitat assessments as cost-effective indicators of instream biotic integrity. Freshwater Biology 51:1941–1958.

Background: Human modifications to the landscape may result in the degradation of aquatic ecosystems as erosion and run-off increase. Reliable indicators of stream water quality historically include the presence and abundance of stream macroinvertebrates representing the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT). Challenges in measuring the presence and abundance of EPT taxa include the technical knowledge of insect identification and substantial time investments. The LOWA is a stream-obligate songbird with a diet consisting largely of EPT taxa. Given the strong association with LOWA, EPT taxa, and stream water quality, LOWA presence, more easily observed than EPT, may serve as a reliable indicator of aquatic ecosystem health.

Objectives: The objectives of this study were to assess the utility of LOWA as bioindicators of aquatic ecosystem health along with the U.S. Environmental Protection Agency (EPA) rapid visual habitat assessment protocol (VHA), which are known to be good indicators of stream integrity.

Methods: The researchers selected study sites with varying degrees of stream integrity. Study sites were surveyed during the breeding seasons of 2002-2004 and LOWA presence was identified as either absent, single male, or breeding pair. EPT taxa were sampled, and metrics calculated included EPT richness, ratio of EPT to macroinvertebrate abundance, the Family Biotic Index (FBI) and macroinvertebrate biomass. The researchers performed EPA VHA to score study sites. Habitat characteristics assessed included epifaunal substrate, embeddedness, velocity/depth regime, sediment deposition, channel flow status, channel alteration, frequency of riffles, bank stability, vegetative protection, and riparian buffer width. The authors constructed linear regression models using the previously measured variables relating to LOWA presence and EPA VHAs and tested model ability to predict abundance and richness of EPT taxa and aquatic ecosystem health.

Location: Athens-Clarke and Macon Counties, Georgia

Findings: The model performed best at predicting variability in stream health when LOWA occupancy was combined with EPA VHAs. LOWA occupancy was a useful indicator of % EPT, FBI, and EPT biomass, but not EPT richness.

Implications: Findings from this study suggested that LOWA is a useful indicator of the health of stream ecosystems. The study highlighted the association of LOWA occupancy with streams characterized by high biotic integrity and factors associated with a healthy stream ecosystem can be useful in predicting LOWA breeding habitat suitability.

Topics: bioindicator, aquatic ecosystem health, LOWA breeding habitat, benthic macroinvertebrates

Mattsson, B. J., and R. J. Cooper. 2009. Multiscale analysis of the effects of rainfall extremes on reproduction by an obligate riparian bird in urban and rural landscapes. Auk 126:64–76.

Background: Headwater riparian ecosystems provide crucial ecological services which may be impacted by climate fluctuations and human disturbance. Precipitation extremes can alter the hydrology of a stream and have serious consequences for the biological community within that ecosystem. The LOWA has been considered a good indicator to overall stream health given its dependence on healthy riparian ecosystems. LOWA breeding success may be affected by climate and anthropogenic factors at multiple spatial and temporal scales.

Objectives: The objective of this work was to determine the relationship between LOWA reproductive success and factors relating to anthropogenic land use, territory quality, and precipitation, at multiple spatial and temporal scales.

Methods: The authors mapped 139 LOWA territories in 13 forested headwater drainages during the Springs of 2002-2005. They recorded habitat quality characteristics such as percent riffles per territory, percent understory cover, percent forest cover, territory area, distance to urban edge, distance to rural edge, percent urban, percent field, and mean daily rainfall. LOWA reproductive success was estimated by quantifying nestling survival rate across territories. The researchers modeled reproduction for 190 nests with a set of 13 potential models using parameters associated with habitat quality and precipitation to determine the most parsimonious model.

Location: north-central Georgia

Findings: Results of this study indicated that intermediate levels of precipitation (3-10 mm day-1) during the nesting period were associated with maximum daily nest survival rates. High levels of precipitation, however, were associated with maximum nestling survival (> 14 mm day -1). Territory size was inversely related with nestling survival. At the larger landscape scale, LOWA nestling survival was lowest when distance to rural was over 160 m but within 1.75 km. Weak associations were found between urban land use factors, distance to urban edge, percent riffles per territory, and year and timing of nesting.

Implications: This research provides important insight into the effects of precipitation on LOWA reproductive success at multiple nesting stages as well as the proximity to rural land use and territory size. Given the significant relationships found among these factors and LOWA reproductive success researcher may better predict how this species will respond to climatic fluctuations and land use changes over time.

Topics: LOWA, climatic fluctuations, land use, reproductive success, riparian ecosystem

Mattsson, B. J., S. C. Latta, R. J. Cooper, and R. S. Mulvihill. 2011. Latitudinal variation in reproductive strategies by the migratory LOWA. Condor 113:412–418.

Background: Long distance migrant birds breeding across a large latitudinal gradient may evolve localized reproductive strategies under different environmental conditions throughout the breeding range. Two hypotheses to explain patterns of variation in reproductive strategies across latitudinal gradients include the season-length hypothesis and the food-limitation hypothesis, the former of which predicts birds breeding towards the southern extent of the range are more productive due to a longer growing season while the latter predicts birds breeding towards the northern extent of the range are more productive due to higher food availability. The LOWA has an extensive breeding range in the eastern United States and serves as a model species for testing the season-length and food-limitation hypotheses.

Objectives: The goal of this study was to observe and quantify differences in LOWA reproductive strategy and output across a wide latitudinal gradient to support or refute either the season-length hypothesis or food-limitation hypothesis.

Methods: The researchers located LOWA nests and documented the number of eggs, nestlings, and fledging's during the breeding seasons of 2003-2005. A statistical model used to compare reproductive success between two localities included number of eggs laid, number of young fledged, nest-survival rate, length of time between nesting attempts, and probabilities of renesting and double brooding.

Findings: Three factors were significantly different between the northern and southern breeding localities including replacement nest egg-laying rate, replacement nest clutch size, and probability of renesting. Overall fecundity was similar across breeding sites.

Location: central Georgia, southwestern Pennsylvania

Implications: The authors showed that average territory size was larger towards the southern extent of LOWA range, and attribute this to comparatively low food-availability in these habitats. This study found that LOWA fecundity did not vary significantly across breeding study sites, although factors associated with replacement nests were significantly different. The authors suggest that this difference may be due to variations in the phenology of insect abundance across the two study sites. Across Georgia and Pennsylvania, insect abundance is similar earlier in the season when first nesting attempt takes place. While insect abundance remains high towards the northern extent of the range, towards the south, insect abundance drops in the latter half of the season when replacement nesting is typically taking place, potentially explaining the comparatively low productivity of replacement nests.

Topics: LOWA, geographic variation, reproductive strategies, fecundity

McClure, C. J. W., and G. E. Hill. 2012. Dynamic versus static occupancy: How stable are habitat associations through a breeding season? Ecosphere 3:art60.

Background: Most studies of breeding habitat use in migratory bird species assume that habitat use does not change throughout the breeding season. With most studies focusing on the early stages of the breeding season, this assumption of static habitat use throughout the season may result in a bias understanding of habitat use. There are several known examples where habitat use has been known to shift across breeding season in birds, highlighting the need expand our understanding of habitat use during the entire breeding season.

Objectives: This study aimed to determine whether habitat use by breeding birds is static across the breeding season.

Methods: The researchers conducted point count surveys throughout the breeding season of 2005, splitting the season into an early round (May 15 – June 15) and later round (June 15 – July 15), with 24 days separating surveys at each site. Percent land cover (classes from Alabama GAP landcover data) and percent canopy cover were calculated within a 100 m buffers surrounding each point location. The researchers used occupancy modeling for each survey periods and tested the hypothesis that birds moved among habitats throughout the breeding season. The LOWA (LOWA) was one 15 species of conservation concern analyzed in this study.

Location: Tuskegee, Alabama

Findings: Factors influencing the detection of LOWA during this study included percent canopy cover and presence of water. LOWA tended to shift towards sites more closely associated with water as the breeding season progressed.

Implications: This study further enforces our understanding of the LOWA's preference for riparian habitats. Since water levels tend to be lower later in the breeding season within the study site, the researchers suggest that LOWA may be selecting sites near perennial streams and water sources.

Topics: LOWA, breeding season, habitat selection, occupancy modeling, Gulf Coastal Plain, Alabama

Means, J. L., and K. E. Medley. 2010. Old Regrowth forest patches as habitat for the conservation of avian diversity in a southwest Ohio landscape. Ohio Journal of Science 110:86–93.

Background: Large patches of mature deciduous forest are declining due to conversion to agriculture and other land use practices. Contiguous tracts of old growth forest provide crucial habitat for forest-dependent bird species such as the LOWA. Given the continued conversion of forest for anthropogenic land use, it is important to understand the contribution of remaining old-growth forest stands to bird diversity to effectively manage the landscape for avian conservation.

Objectives: The aim of this study was to quantify avian diversity in small patches of old-growth forest, focusing on mature forest-associated species. The authors also investigated how avian diversity differs among remnant forest stands in relation to physical, ecological, and landscape characteristics.

Methods: The researchers used aerial photography to map old regrowth forests and selected nine patches ranging in size from 0.9 to 11.2 ha. Point count surveys were conducted during May and June 2009 to quantify avian diversity. Habitat characteristics measured and compared included topography, tree species, diameters at breast height (dbh), percent canopy cover, percent woody ground debris, tree height for all canopy and subcanopy trees greater than 10 cm (dbh), and density of snags. The researchers compared species presence (or absence), species richness, and relative percent of species identified with regional bird data.

Locations: south-western Ohio

Findings: The nine study patches were all characterized as closed canopy, deciduous forests with well-developed understories. During this study LOWA were detected within study patches, including a patch as small as 4.2 ha that was characterized as partial floodplain.

Implications: The results of this study support the association of LOWA with mature, old growth forests and water. This study also provides evidence of LOWA presence in patches much smaller than those typically occupied by LOWA.

Topics: eastern deciduous forest, forest-dependent birds, avian diversity, old growth forests

Mueller, A., D. Twedt, and C. Loesch. 1999. Development of management objectives for breeding birds in the Mississippi Alluvial Valley. Proc. of the 1995 Partners in Flight … 1–15. <http://www.lmvjv.org/library/research_docs/2000 RMRS-P-16_12-17 Mueller Twedt Loesch.PDF>.

Background: Bird Conservation Plans (BCPs) specific to individual physiographic regions (e.g., the Mississippi Alluvial Valley or MAV) are important for effective conservation. Given the limitations to obtaining complete and accurate ecological information, the best conservation approach may require action based off of limited information. With an adaptive management approach, however, as more relevant information becomes available to the scientific community, conservation plans and recommendations can be modified to ensure a more informed approach.

Objectives: The goal of this paper was to provide a model for establishing regional avian conservation plans based off of the best available information.

Methods: The authors present a six-step approach for establishing conservation goals for
avian species and demonstrate the use of this approach for the MAV. They first established priority species for the region followed by habitat priorities. Next, they identified habitat requirements to support populations of identified priority species within these habitats, such as forest area. The distribution of suitable habitat needed to meet individual species' population requirements is then determined using GIS analyses. Next, researchers set site-specific objectives and goals for the entire population for each species.

Locations: Mississippi Alluvial Valley

Findings: Using the process outlined in this paper, the researchers estimate that minimum forest patch size to support 500 breeding LOWA is 7,200 acres.

Implications: This study provides a useful tool for land managers that can help prioritize areas within the region based on that habitats ability to support avian priority species such as LOWA. The information provided here further supports the association of LOWA with large forest patches. With optimal area quantified, researchers and managers are better able to implement effective conservation.

Topics: Mississippi Alluvial Valley, Bird Conservation Plan, Partners in Flight, forest area requirements, priority habitats, priority species

Mulvihill, R. S., F. L. Newell, and S. C. Latta. 2008. Effects of acidification on the breeding ecology of a stream-dependent songbird, the LOWA (Seiurus motacilla). Freshwater Biology 53:2158–2169.

Background: Riparian ecosystems are vulnerable to acidification resulting from both mining and acid rain. Benthic macroinvertebrates from the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT taxa) are an important food source for the stream obligate songbird, the LOWA. EPT are acid-intolerant and can't persist in acidified streams. Given that LOWA are often associated with territories consisting of high proportions of EPT taxa, stream acidification may have serious implications for LOWA presence and reproductive success.

Objectives: The objective of this study was to investigate the relationship between stream acidification and LOWA abundance and breeding success.

Methods: The researchers surveyed reaches roughly 2-3 km in length along 8 first and second order streams from 1996-2005 (n=2) and 1998-2000 (n=6). Data recorded along each stream included % EPT and stream chemistry. The researchers banded and observed LOWA on each stream. All nesting attempts were documented, and nests were monitored for nesting success, which was defined as at least one fledged individual.

Locations: Laurel Highlands, southwestern Pennsylvania

Findings: The researchers monitored a total of 207 LOWA territories on acidic and circumneutral streams. Acidic streams were characterized by lower breeding density, larger territories, and lower macroinvertebrate biomass. Overall %EPT was similar, but there was a significantly lower proportion of Ephemeroptera taxa in acidic streams versus circumneutral streams. The number of successfully fledged young was significantly lower on acidified stream. Site fidelity was highest in circumneutral streams

Implications: This study showed that acidification of streams likely has detrimental effects on the LOWA breeding population.

Topics: LOWA, acidification, riparian ecosystem health, mining, benthic macroinvertebrates

Murray, N.L., and F. Stauffer. 1995. Nongame Bird Use of Habitat in Central Appalachian Riparian Forests. The Wildlife Society Stable URL:http://www.jstor.com/stable/3809118. 59:78–88.

Background: Riparian habitats generally support high avian diversity, as they represent an ecotone with unique characteristics between aquatic and upland habitats. In the central Appalachians, however, the gradient between riparian zones and upland habitats is somewhat uniform, and it's unclear how these habitats impact the composition of the avian community.

Objectives: The aim of this study was to investigate the influence of riparian habitats in hardwood and hemlock forests in the central Appalachians on avian species richness and abundance.

Methods: The researchers conducted point counts during the breeding seasons of 1990 and 1991 on 16 sites along second order streams with riparian buffers at least 60 meters wide, characterized as mature, second growth forest. Habitat characteristics were measured for each site, including snag abundance, canopy and understory tree species composition and height, ground cover, and distance to stream.

Locations: Jefferson National Forest, southwestern Virginia

Findings: Unsurprisingly, this study found that LOWA were most often detected within four meters of a stream. LOWA were absent from sites farther than 154 meters from a stream, demonstrating a statistically significant response to distance to stream. This study also showed that LOWA were statistically more likely to occupy riparian areas dominated by deciduous hardwoods rather than hemlock.

Implications: This study supports a stronger association with deciduous riparian habitats than with hemlock-dominated riparian habitats. This information is important as it provides more evidence to increase confidence in the ability to predict habitat suitability for the LOWA in southwestern Virginia.

Topics: forest habitat, neotropical migrants, nongame birds, riparian, Virginia

Nott, M. P., D. F. DeSante, and N. Michel. 2003. Management strategies for reversing declines in landbirds of conservation concern on military installations: A landscape-scale analysis of maps data. A report to the U.S. Department of Defense Legacy Resources Management Program. 123.

Background: The United States Department of Defense (DoD) provides substantial breeding and stopover habitat for bird species in North America. One challenge natural resource managers face on these military installations involves the juxtaposition of necessary military activity, disturbance and avian conservation. Ecological models can help land managers understand how landscape patterns can impact the avian community, enabling them to better balance conservation and military operations.

Objectives: The goal of this study was to develop landscape-scale models to guide management practices intended to reverse declining population trends in neotropical migratory birds.

Methods: The researchers used banding data from 1994-2001 for 13 DoD installations for 31 landbird species, in conjunction with land cover data to construct demographic-landscape models and explain the relationship of landscape patterns with reproductive success, number of adults and young, and populations trends.

Locations: eastern and central United States

Findings: LOWA experienced increasing population trends on four of the seven installments where they were present, while a negative trend was found on three installments. The model generated showed that LOWA were associated with large tracts of landscape characterized with 50-90% forest cover (600-1100 ha of forest in a 2-km radius area) that contain 50-100ha of water. Positive relationships were found between the number of young and adults, along with reproductive success, and the total amount of water and forest edge. The authors also found a negative association with amount of shrubland cover and water edge, but the ecological significance of these findings is not clear.

Implications: While the findings support that LOWA are associated with stream and heavily forested habitats, the authors suggest that the positive association with LOWA abundance and reproductive success and forest edge indicates that some fragmentation may be beneficial, mainly with regards to juvenile dispersal. The authors suggest that LOWA management include the maintenance of upland forested riparian habitats with dense, shrubby forest edge habitat. In addition to this recommendation based on their model, the authors also site previously established guidelines for LOWA management that included upland streams buffered by at least 50 meters of forest on each side, with forest area totaling over 100ha. No reference is provided for these guidelines, however.

Topics: avian conservation, land management, demographic-landscape models, Birds of Conservation Concern

Parnell, J.F. 1969. Habitat Relations of the Parulidae during Spring Migration. University of California Press on behalf of the American Ornithologists' Union Stable URL: http://www.jstor.org/stable/4083411. Spring 86:505–521.

Background: Many wood warblers, including the LOWA, are uniquely adapted to different habitat niches. Given these adaptions, it is likely that birds exhibit habitat selection and preferences during migration as well as the breeding and wintering seasons. Little work, however, has focused on habitat use by warblers during migration.

Objectives: The goal of this study was to determine the relationships between habitat characteristics and habitat use among warblers during Spring migration.

Methods: The researcher sampled birds along 19 transects over the course of two consecutive spring migration and nesting seasons (1962 and 1963). Transects included seven forest types including floodplain forest, pine forest, oak-hickory forest, pine-hardwood forest, dry thicket, wet thicket, and beech forest. Analysis of Variance (ANOVA) was used to determine difference in habitat selection across warbler species.

Locations: Raleigh, North Carolina

Findings: This study showed that LOWA selected floodplain forest and beech forest habitats and were absent from all other forest types in this study.

Implications: This study presents information that can be used to predict LOWA habitat suitability within the study region, showing that LOWA prefer floodplain and beech forest habitats over the other forest types.

Topics: Warblers, migration, habitat use, forest type

Peak, R. G., and F. R. Thompson. 2006. Factors Affecting Avian Species Richness and Density in Riparian Areas. Journal of Wildlife Management 70:173–179.

Background: Riparian ecosystems support a high degree of avian biodiversity, and are conservation targets to help mitigate the impacts of habitat loss on birds. Many studies have focused on the influence of riparian width on avian richness and abundance, but few have looked at other characteristics such as vegetation composition and structure. The influence of grassland-shrub buffers adjacent to forested riparian areas on avian abundance and diversity is largely unknown.

Objectives: The aim of this study was to assess how grassland-shrub buffer strips (presence and width) influence avian species richness.

Methods: The researchers surveyed bird communities during the 2000 and 2001 breeding seasons along three narrow (55-95 m) and three wide (400-530 m) forested riparian areas with an adjacent grassland-shrub buffer as well as three narrow and three wide riparian areas with no grassland-shrub cover. Habitat features measured included dbh (greater than 1.3 meters high and over 0.5 cm), woody stems taller than 50 cm (species and dbh), ground cover, and percent canopy cover. Proportion of bottomland to upland forest at each study was also calculated, along with avian species richness and mean density for forest area-sensitive and grassland-shrub-nesting birds.

Locations: northeastern Missouri

Findings: This study showed that riparian buffer width best predicted LOWA density. LOWA were found at higher densities in wide riparian zones, and highest in those with no grassland-shrub buffer.

Implications: The results of this study further support the association of LOWA with wide forested riparian buffers, (400-530 m).

Topics: avian species richness, breeding bird density, buffer strip, forest area-sensitive species, grassland-shrub-nesting species, information theoretic approach, Missouri, riparian area, songbird

Pennington, D. N., and R. B. Blair. 2011. Habitat selection of breeding riparian birds in an urban environment: Untangling the relative importance of biophysical elements and spatial scale. Diversity and Distributions 17:506–518.

Background: Urbanization presents a substantial challenge to efforts to conserve biodiversity. Despite this threat, many native bird species continue to inhabit urban areas. The spatial arrangement of urban and natural habitat features may influence avian habitat selection across multiple spatial scales within an urban environment.

Objectives: The objectives of this study were to investigate the influence of habitat characteristics at both small and large scales and compare the relative importance of habitat characteristics at these different scales to avian density. In addition, the authors sought to identify the spatial scale to which different bird species show the strongest response to habitat characteristics.

Methods: The researchers conducted avian surveys at 71 plots arranged along an urban gradient during the breeding seasons of 2002, 2004, 2005, and 2006. Relative density for 48 bird species was modeled to assess the relationship between density and small-scale woody vegetation composition and landscape level features including tree cover, grass cover, and building density.

Locations: Cincinnati, Ohio

Findings: The model suggested a positive response of LOWA to canopy height, which was an important variable for predicting LOWA density.

Implications: These findings support the association of LOWA with mature forest.

Topics: Birds, conservation, biogeography, habitat selection, heterogeneity, landscape spatial scale, urban

Prosser, D. J., and R. P. Brooks. 2011. A Verified Habitat Suitability Index for the Louisiana Waterthrush (Un Índice Verificable de Adecuación de Habitat Para *Seiurus motacilla*) Published by: Blackwell Publishing on behalf of Association of Field Ornithologists Stable URL: http://www.jstor. Habitat 69:288–298.

Background: Habitat Suitability Index (HSI) models are valuable tools used to guide wildlife management decisions. Testing the accuracy of HSIs is critical if these models are to be used in decision making. Methods for testing the accuracy of a HSI include calibration with qualitative data, verification with quantitative presence data, or validation through quantification of some population measure.

Objectives: The goal of this study was to generate and verify a HSI for the LOWA.

Methods: Surveys for LOWA presence were conducted during Spring of 1994 and 1995. Variable selection for model development was guided by a thorough literature review. Previous research showed that during the breeding season LOWA are riparian obligates occupying first through second order streams with microtopography consisting of riffles and pools. Preferred land cover included interior forest consisting of a mix of deciduous and coniferous canopy cover with an understory composed of herbaceous vegetation, moss, and ferns. Secondary habitat included slow streams and river swamps. The LOWA was found to build nests in stream banks and the roots of upturned trees. Variables selected included cover (forest cover, percent shrub cover, ratio of deciduous to coniferous canopy cover, herbaceous cover density and height), food (stream order and microtopography, stream clarity and substrate), nesting (presence of fallen trees, stream bank slope and herbaceous cover type), and landcover.

Findings: The authors successfully developed a HSI for LOWA, specific to the Mid-Atlantic region, using eight predictor variables relating to cover, food, and nesting. Verification showed that areas where LOWA is present have higher HSI than areas where LOWA is absent.

Location: Blair, Centre, Huntingdon, and Union counties, Pennsylvania

Implications: The HSI developed here solidifies our understanding of optimal LOWA breeding habitat. The use of the variables relating to cover, food, and nesting, highlights the importance of these habitat features in estimating habitat suitability for this riparian specialist and can be used to support future HSIs developed for LOWA.

Topics: breeding habitat, habitat suitability index modeling, riparian habitat, LOWA

Robbins, S. C., D. K. Dawson, and B. A. Dowell. 1989. Habitat Area Requirements of Breeding Forest Birds of the Middle Atlantic States. Wildlife Monographs 103:1–34.

Background: It is well documented in the literature that large tracks of contiguous forest area are key to the conservation of many bird species. Different species, however, have different area requirements. Understanding the area requirements for species of conservation concern can help managers prioritize areas for conservation.

Objectives: This study aimed to determine minimum area requirements and identify habitat characteristics associated with relative abundance for 75 species of forest birds, including the LOWA.

Methods: The authors sampled forests across four geographic regions throughout the Mid-Atlantic region from 1979-1983. Study sites contained forests falling into one of eight area classes (< 2 ha, 2-6 ha, 6-20 ha, 20-50 ha, 50-150 ha, 150-500 ha, 500-1,500 ha, and >1,500 ha). Vegetation and habitat characteristics were measured at 469 point count locations and stepwise multiple regression analysis was used to determine which variables influenced relative abundance for 75 species of forest birds. The authors used logistic regression to assess the association between species probability of occurrence and forest area whenever forest area was identified as an important variable.

Locations: Maryland

Findings: This study found that, of 15 variables, increased LOWA relative abundance was associated with higher tree basal area, larger forest area, increased moisture gradient, a lower percentage of coniferous forest cover, and increased foliage density at 0.3-1 meters. Logistic regression showed that optimal forest area for LOWA was at least 3,000 ha, while the suggested minimum area for breeding was 350 ha. LOWA were detected in patch sizes as small as 24.7 ha.

Implications: The findings of this study highlight several habitat characteristics that influence LOWA relative abundance, including tree basal area, forest patch size, moisture gradient, proportion of coniferous forest cover, and understory foliage density. Optimal patch size for maximum LOWA abundance was >3,000 hectares, providing further evidence that LOWA rely on large areas of contiguous and mature forest. This number, along with the minimum area suggested for breeding is useful in establishing a gradient in habitat suitability based on forest patch area.

Topics: Forest birds, habitat structure and composition, LOWA, forest management

Robinson, S.K. and Wilcove, D.S.1999. Forest fragmentation in the temperate zone and its effects on migratory songbirds. Bird Conservation International 4:233-249.

Background: Neotropical migrant populations are on the decline and forest fragmentation and forest loss is largely to blame. Among other negative consequences, such as lower dispersal and colonization rates, forest fragmentation may lead to increased nest predation and cowbird parasitism, as cowbirds are generally found along the forest edge rather than the interior.

Objectives: The goal of this study was to present evidence of the declining neotropical migrant songbird populations and discuss the association of this trend with forest fragmentation in breeding habitats while providing recommendations for forest management practices to minimize fragmentation.

Methods: Evidence for declining migratory songbird populations was compiled from the literature, along with the factors that facilitate increased extinction rates in response to fragmentation. These factors include dispersal and colonization, changes in forest successional stage, food resources, microhabitats, nest predation, and brood-parasitism.

Locations: Midwest, North America

Findings: The information compiled in this study suggest higher rates of brood parasitism in LOWA populations breeding in a fragmented landscape (50% parasitized) than in a moderately fragmented, forested landscape (25% parasitized). Brood parasitism reduced reproductive success (number of successfully fledged offspring) in LOWA by 73%. Despite these rates of parasitism in fragmented habitats along with reduced productivity, this paper suggests that LOWA typically avoid brood parasitism by selecting interior forest habitats.

Implications: The information presented here suggests that, while brood parasitism may be relatively lower in LOWA than in other species, this species is still vulnerable, particularly in a fragmented landscape.

Topics: Forest fragmentation, neotropical migratory songbird, brood parasitism, cowbird, reproductive success

Sauer, J. R. E., J. E. Hines, K. L. Fallon, J. Pardieck, D.J., Ziolkowski, and W. A. Link. 2014. The North American Breeding Bird Survey, Results and Analysis 1966-2012. Version 02.19.2014. Laurel, MD. <http://www.mbr-pwrc.usgs.gov/bbs/bbs.html>.

Background: The Breeding Bird Survey (BBS) was established during the 1960s as a continental-wide monitoring programs for breeding birds in North America.

Objectives: The objective of the Breeding Bird Survey (BBS) is to systematically assess the status and trends of North American bird populations at both continental and regional scales with the aim to guide effective conservation and management strategies.

Methods: The BBS consists of 3,700 routes along roads, each 24.5 miles long with 50 stops at 0.5-mile intervals, where researchers conduct three-minute point counts.

Locations: North America

Findings: Results from years of BBS data suggest that LOWA have been declining in the WGCPO since 1966.

Implications: The population decline detected by the BBS suggests that LOWA is a species of conservation concern within the WGCPO region.

Topics: North America, breeding birds, United States Geological Survey, population trends

Schulz, C. A., D. M. Leslie, R. L. Lochmiller, and D. M. Engle. 1992. Herbicide effects on cross timbers breeding birds. Journal of Range Management 45: 407-411.

Background: Herbicides used in range management throughout the Cross Timbers region of central Oklahoma may have effects on breeding forest birds.

Objectives: The goal of this study was to assess the impacts of tebuthiuron and triclopyr herbicide use non-game forest breeding birds, including the LOWA.

Methods: This study included nine pastures representing three replicates of three experimental treatments as well as a control site with no herbicide application. In 1988 and 1989, habitat measurements were taken at a series of 10.8-hectare grids throughout the study site and included foliage height and diversity, density of snags and slash (downed debris), snag basal area, slash volume, percent herbaceous ground and shrub cover, and percent canopy cover. Bird surveys were conducted on all grids to identify species and estimate densities for each species at each grid.

Location: central Oklahoma

Findings: Control sites had greater canopy cover, lower snag density, lower slash volume, and lower herbaceous cover. This study found that the LOWA was statistically more likely to be found on control plots. LOWA were absent from all nine treatment plots in this study. Density of LOWA territorial males was roughly six per 10.8-hectare plot.

Implications: The results of this study provide further evidence to support the association of LOWA with closed canopy forests. This study also highlighted a potential relationship between LOWA presence and percent herbaceous ground cover, as well as snag and slash densities, although these associations are not prominently supported in the literature.

Topics: Breeding non-game birds, herbicide, habitat-alteration, Oklahoma, tebuthiuron, triclopyr

Skinner, C. 2003. A breeding bird survey of the natural areas at Holden Arboretum. Ohio Journal of Science 103:98–110.

Background: Avian community diversity and composition can be important proxies for overall ecosystem health. Bird surveys are an efficient way to monitor avian communities and ecosystem health.

Objectives: The goal of this study was to estimate species richness and abundance of breeding birds in various habitats.

Methods: The researchers conducted avian surveys during Spring, 2001, recording observations of individuals for each species.

Locations: Cleveland, Ohio

Findings: Results from this study indicate that LOWA preferred both mature upland and bottomland forest.

Implications: This study adds to the breadth of information supporting an association of the LOWA with both mature upland and bottomland forest.

Topics: Breeding birds, ecosystem health, bioindicator, Ohio

Stucker, J. H., and F. J. Cuthbert. 2000. Biodiversity of southeastern Minnesota forested streams: relationships between trout habitat improvement practices, riparian communities and the LOWA. Natural Heritage and Nongame Wildlife Program 1–146.

Background: The LOWA is a species of conservation concern in Minnesota due to a restricted range and an observed decrease in the population over time. Conservation of habitat is critical for this riparian specialist. To prioritize areas for protection in Minnesota, towards the northern extent of its range, it is crucial to understand what habitat characteristics are associated with LOWA reproductive success.

Objectives: The goal of this study was to better understand LOWA reproduction and nest site characteristics as well as assess habitat differences between areas where LOWA were found breeding and where LOWA were absent.

Methods: The researchers included 22 segments of first through third order streams with roughly 90% canopy cover. Point counts were conducted during spring of 1995 and 1996 to assess avian communities and playbacks were used to detect LOWA. LOWA nests were identified and tracked to determine nesting success. Measured nest-site characteristics included height above water, distance to stream, and composition of nest material. To assess the composition of the aquatic community the researchers sampled benthic macroinvertebrates from riffles and identified to species or the finest taxonomic level possible. The researchers measured Simpson and Brillouin diversity indices, species richness, proportion of representatives from the orders Ephemeroptera, Plecoptera, Trichoptera (EPT taxa) and Chironomid dominance, and three LOWA specific indices of food intake. Measures of water quality included two indices: The Hilsenhoff Biotic (HBI) and Family Biotic (FBI) Indices. Stream and streambank measurements included length of riffles, runs, and pools within each stream segment as well as percentage of exposed rock. Streambank slope, percent of exposed bank, and vegetative community were also recorded.

Locations: southeastern Minnesota

Findings: The researchers observed 24 nests from 22 stream segments. Average territory length was 460 meters. Average nest height was 1.3 meters above the waterline and average distance to stream was 1.4 meters. Nests occurring along the streambank were generally associated with a slope of 69°. Maple leaves were most abundant among nesting material and nests, on averaged, faced 94°. Of the 24 nests observed, 23 fledged at least one fledgling. Cowbirds parasitized at a minimum of 15 nests, which resulted in a decline of fledgling success from 2.3 per nest to 0.8 per nest. In general, the avian community in areas where LOWA were found nesting included significantly more forest interior species and fewer species adapted to disturbed habitats. Streams where LOWA were found nesting had significantly more riffles, fewer runs, higher percentage of exposed rock, more bare soil on the streambank, and a small bank slope, than those where LOWA were absent. Proportion of EPT taxa were higher in streams segments where LOWA were present, although there was no significant difference in water quality.

Implications: This study increases our understanding of LOWA breeding habitat towards the northern extent of its breeding range, highlighting critical habitat features such as nest site characteristics, food availability, and stream morphology. This information can be used to help prioritize areas for LOWA conservation based on these habitat characteristics.

Topics: LOWA, nest site characteristics, riparian ecosystem, reproductive success, conservation

Thompson, B. n.d. Process for establishing priority refuge resources of concern.

Background: Priority refuge resources of concern are useful in guiding ecological goals and objectives for the refuge. Most priority resources on refuges are plants or animals of conservation concern.

Objectives: The goal of this Appendix was to describe the procedures followed to establish priority resources of concern for Silvio O. Conte National Fish and Wildlife Refuge.

Methods: The process for establishing priority resources of concern included collecting information and data from experts to create a list of potential species and habitats of conservation concern within the watershed.

Locations: Connecticut, Massachusetts, New Hampshire, and Vermont

Findings: The collective, expert-derived information regarding LOWA presented in this Appendix suggest that breeding habitat for this species includes large tracts of mature, contiguous hardwood forest (250 acres or more). Forest types important for LOWA breeding include deciduous or mixed forests along medium to high-gradient first to third order, perennial streams.

Implications: The information here provides evidence that can guide conservation planning and inform models predicting habitat suitability in this species. This work reinforces the LOWAs association with mature, contiguous hardwood forests along first and second order perennial streams.

Topics: priority refuge resources of concern, Silvio O. Conte National Fish and Wildlife Refuge,

Tirpak, J M, D. T. Jones-Farrand, F. R. Thompson, D. J. T., W. B. Uihlein. 2009. Multiscale habitat suitability index models for priority landbirds in the Central Hardwoods and West Gulf Coastal Plain/Ouchitas Bird Conservation Regions. U.S. Department of Agriculture, Forest Service General Technical Report NRS-49, Northern Research Station, Newtown Square, Pennsylvania, USA.

Background: The North American Landbird Conservation Plan was established with several goals, one of which was to translate population targets for species of concern to habitat goals in the Central Hardwoods and West Gulf Coastal Plain/Ouchitas regions. The LOWA is a species of concern in both regions.

Objectives: This goal of this study was to determine the landscapes' ability to sustain specified populations of priority species, such as LOWA, based on the extent of available habitat using a Habitat Suitability Index (HSI) modeling approach.

Methods: The HSI developed for LOWA in this study was informed by the following variables: landform (floodplain-valley, terrace-mesic, and xeric ridge), landcover (low-density residential, transitional-shrubland, deciduous, evergreen, mixed, orchard-vineyard, woody wetlands), successional age class (grass-forb, shrub-seedling, sapling, pole, and saw), distance to stream, percent canopy cover, density of small stem vegetation, forest patch size, and percent forest loss in a 1 km radius.

Findings: HSI model verification and validation showed a positive association between LOWA presence and average HSI score, suggesting that the model developed in this study is appropriate in predicting the landscapes' ability to sustain LOWA populations. Across all landform types, LOWA habitat suitability score was highest in deciduous forest and woody wetlands with mature stands. Optimal distance to stream was less than 30 meters while optimal canopy cover was >90%. LOWA habitat suitability decreased with increasing small stem density. Optimal patch size was greater than 3,200 hectares and optimal landscape composition consisted of > 90% forest within a 1 km radius.

Location: West Gulf Coastal Plain/Ouchitas and Central Hardwood regions, eastern United States

Implications: This study showed that the variables used in this HSI are valuable indicators of LOWA habitat suitability, demonstrating that these factors are crucial indicators of LOWA breeding habitat quality.

Topics: LOWA, Habitat Suitability Index, landbird conservation, West Gulf Coastal Plains/Ouchitas, Central Hardwood,

Trevelline, B. K., S. C. Latta, L. C. Marshall, T. Nuttle, and B. A. Porter. 2016. Molecular analysis of nestling diet in a long-distance Neotropical migrant, the LOWA (Parkesia motacilla). Auk 133:415–428.

Background: Composition and availability of food resources are crucial factors for the success of populations of long-distance neotropical migrants. Next-generation and DNA barcoding techniques allow for non-invasive methods to determine the dietary composition of birds and other taxa from fecal matter. The LOWA is a species of concern given it is a useful bioindicator for stream and riparian ecosystem quality. LOWA reproductive success is lower for breeding pairs with territories along streams characterized by poor water quality. This negative association of LOWA breeding success is largely attributed to the availability of benthic macroinvertebrates from the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT taxa), which are extremely sensitive to changes in water chemistry that result from stream degradation.

Objectives: The purpose of this study was to use molecular techniques to determine the dietary composition of LOWA nestlings and assess how this change throughout the nesting season.

Methods: Fecal samples were collected from 130 LOWA nestlings throughout the 2013 nesting season. The researchers collected benthic macroinvertebrates along the streams where nestlings were sampled several times throughout the season. DNA was extracted from collected fecal samples and a region of mitochondrial DNA was amplified and sequenced using general arthropod DNA barcode primers in order to detect the composition of arthropods in nestling diet throughout the nesting season.

Location: Van Buren Co. and Conway Co., Arkansas and Westmoreland Co., Pennsylvania

Findings: Benthic macroinvertebrate sampling showed mean relative abundance of EPT taxa was moderately high and similar across study sites. DNA analysis revealed that taxonomic richness of LOWA nestling diet was similar in both study sites at the order level. At a finer taxonomic resolution, richness was higher in Pennsylvania than in Arkansas. The most common order found in nestling fecal samples in the Arkansas study site was Diptera, followed by Lepidoptera. In Pennsylvania, the most common order was Lepidoptera. When considering only EPT taxa, Ephemeroptera were the most common across both study sites. Ephemeroptera richness was higher in Pennsylvania. Orders Plecoptera and Trichoptera were absent from nestling fecal samples in Arkansas and only present in a few samples from Pennsylvania. The analysis of nestling diet over time in Arkansas suggests the three most common orders detected in fecal samples (Lepidoptera, Diptera, and Ephemeroptera) were found at similar rates throughout the nesting period. In Pennsylvania, the detection of Lepidoptera increased throughout the nesting season while Ephemeroptera decreased.

Implications: This study showed that LOWA may be more reliant on terrestrial taxa, specifically Lepidoptera and Diptera, than previously believed. Of the EPT taxa, Plecoptera and Trichoptera were underrepresented, despite the availability of these food sources. This new understanding suggests that, while the EPT taxa may be important food sources in the early breeding season, LOWA nestling diet does not appear to be largely dependent on this group during the post-incubation period. Therefore, the quality and composition of terrestrial habitats in LOWA territories may be very important for nestling survival and should be considered when assessing the overall quality of LOWA habitat.

Topics: Louisiana Waterthrush, DNA barcoding, next-generation sequencing, nestling diet, Lepidoptera, Ephemeroptera, Diptera

Trevelline, B. K., T. Nuttle, B. D. Hoenig, N. L. Brouwer, B. A. Porter, and S. C. Latta. 2018. DNA metabarcoding of nestling feces reveals provisioning of aquatic prey and resource partitioning among Neotropical migratory songbirds in a riparian habitat. Oecologia 187:85–98. Springer Berlin Heidelberg. <https://doi.org/10.1007/s00442-018-4136-0>.

Background: Emergent aquatic insects are an important food source for many neotropical migratory songbirds, in particular, the LOWA, which breed only in riparian habitats. Although it is well understood that LOWA rely heavily on these emergent aquatic insect taxa in riparian habitats, this understanding exists at a coarse taxonomic level. Previous studies may have missed meaningful information that could be obtained by identifying prey to the genus or species level, such as preferences for specific taxa and taxa that vary in their tolerance to stream pollution. Understanding, at a finer taxonomic scale, a preference for prey sensitive to pollution could be useful in identifying suitable LOWA habitat based on the proximity of possible sources of pollution related to human activity.

Objectives: The goal of this study was to determine nestling diet using DNA metabarcoding of three breeding neotropical songbirds, including the LOWA.

Methods: Focusing on LOWA, as well as the Acadian Flycatcher and Wood Thrush, the researchers systematically located and monitored a total of 43 nests (9 LOWA nests), obtaining 137 nestling fecal samples during spring of 2015. DNA was extracted and sequenced from fecal samples using universal arthropod COI “mini-barcode” primers. An index of dietary niche breadth was calculated, and an analysis of variance (ANOVA) was used to determine differences in aquatic-prey preferences across the three focal species. Other factors measured included interspecific dietary niche overlap and interspecific differences in diet variability.

Location: southwestern Pennsylvania

Findings: LOWA nestling diets were characterized by lower dietary richness and a narrower dietary niche compared to the Acadian Flycatcher and the Wood Thrush. The most frequently detected order of arthropod across all nestlings was Lepidoptera (99% of all nestling diets). Terrestrial Lepidopterans that were most common included Terebidae, Geometridae, and Noctuidae. Dipterans were also common among nestling diets with the exception of LOWA nestlings where most Dipterans consumed were aquatic. This study found several orders were largely unique to LOWA nestlings, including Decapoda, Ephemeroptera, Megaloptera, Plecoptera, and Trichoptera. LOWA nestlings also consumed a significantly larger proportion of aquatic prey taxa than the other two species.

Implications: The results from this study provide further evidence that LOWA primarily forage on benthic and emergent aquatic insect taxa. The significant differences found in the preference of LOWA for aquatic taxa suggest resource partitioning among the three focal species. This study also supports previous work suggesting that LOWA will opportunistically consume terrestrial Lepidoptera, deviating from their typical aquatic invertebrate prey. The high taxonomic resolution of this study provides a better understanding of LOWA nestling diet, suggesting, down to the genera level, that LOWA frequently consume prey that are sensitive to changes in water-quality associated with human activity.

Topics: nestling diet, Louisiana Waterthrush, riparian habitat, emergent aquatic insects.

Twedt, D. J., J. M. Tirpak, D. T. Jones-Farrand, F. R. Thompson, W. B. Uihlein, and J. A. Fitzgerald. 2010. Change in avian abundance predicted from regional forest inventory data. Forest Ecology and Management 260:1241–1250. Elsevier B.V. <http://dx.doi.org/10.1016/j.foreco.2010.07.027>.

Background: As climate conditions continue to change, the distributions of avian habitats are expected to respond to new ecological conditions. Understanding avian response to future habitat projections is crucial for effective conservation planning. The Forest Inventory and Analysis (FIA) is useful in assessing trends in forest area, while the Breeding Bird Survey (BBS) is used to track trends in avian populations. Historical relationships between these two data sources can guide predictions for avian response to future changes in forest type and distribution.

Objectives: The aim of this study was to investigate the historical relationship between forest-dependent bird species with forest area, forest composition, forest age, and land ownership in the southeastern United states.

Methods: The researchers used BBS data in conjunction with FIA data to model the relationship between avian abundance and forest characteristics.

Locations: southeastern United States

Findings: The model generated in this study suggested that LOWA abundance is negatively associated with the proportion of hardwood forest with bottomland species.

Implications: The negative relationship detected between LOWA abundance and the proportion of hardwood forest with bottomland species suggests a preference for upland, hardwood forested habitats over bottomland hardwood habitats.

Topics: Abundance, birds, Breeding Bird Survey, Forest Inventory Analysis, habitat, prediction, Southeastern United States, temporal change

Vance, M. D., L. Fahrig, and C. H. Flather. 2003. Effect of reproductive rate on minimum habitat requirements of forest-breeding birds. Ecology 84:2643–2653.

Background: Understanding how species will respond to habitat loss is crucial to implement effective avian conservation. Forest area requirements vary greatly across forest-breeding birds, and changes to forest area may impact reproductive rates and success and ultimately population persistence within an area. One theory relating reproductive rate with forest area suggests that birds with higher reproductive rates require less habitat to ensure population persistence than birds with lower reproductive rates.

Objectives: The goal of this study was to test the theory that birds with higher reproductive rates require less habitat for long-term population persistence than birds with low reproductive rates.

Methods: BBS data was used to determine "proportion presence" for 41 forest-breeding bird species over a 10-year study period. The researchers used the U.S. Geological Survey (USGS) Land Use and Land Cover (LULC) data set to estimate percent forest cover at each of 779 focal landscapes.

Locations: central and eastern United States

Findings: This study suggested that LOWA probability of presence is highest in areas with 99% forest cover.

Implications: This study provides further empirical evidence supporting the LOWAs dependence on large patches of forest.

Topics: Breeding Bird Survey, deforestation, extinction threshold, forest-breeding birds, habitat amount, habitat loss, minimum area requirements, minimum habitat requirements, population persistence, reproductive rate

Wood, P. B., M. W. Frantz, and D. A. Becker. 2016. LOWA and benthic macroinvertebrate response to shale gas development. Journal of Fish and Wildlife Management 7:423–433.

Background: The detrimental effects of shale gas development on natural ecosystems and biodiversity include deforestation and fragmentation, changes in runoff and hydrology, increased erosion and water contamination, and stream sedimentation. The LOWA is a stream-obligate bird and LOWA density is associated stream pH and the relative abundance of insects representing the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT taxa). Given this dependence, LOWA are vulnerable to environmental changes associated with shale gas development and considered to be good indicators of riparian ecosystem health.

Objectives: The goal of this study was to assess the impacts of shale gas development on benthic macroinvertebrate communities and LOWA density, nesting success and habitat quality.

Methods: The researchers sampled benthic macroinvertebrates, mapped LOWA territories, observed nesting success and assessed riparian habitat quality using a previously generated habitat suitability index model and the Environmental Protection Agency Rapid Bioassessment Protocol in streams both impacted and unimpacted by shale gas development. The relationship between LOWA metrics including territory density, clutch size, and number of fledglings, and benthic macroinvertebrate metrics was assessed using a Pearson correlation matrix. Three models included 1) a set of temporal and rainfall covariates, 2) covariates relating to habitat quality, and 3) covariates associated with the macroinvertebrate community.

Location: Lewis Wetzel Wildlife Management Area, West Virginia

Findings: This study showed that benthic macroinvertebrate metrics that differed between shale gas development impacted streams and unimpacted streams included overall EPT richness, genus-level index of most probable stream status (GLIMPSS), density of small (0-3 millimeters in length) macroinvertebrates, and the number of intolerant taxa – all of which were higher in unimpacted streams, indicating higher aquatic ecosystem quality. A strong and significant positive correlation was found between LOWA density and benthic macroinvertebrate metrics including GLIMPSS, biomass, and density, with the strongest correlation being with EPT density.

Implications: This study provided further evidence of the negative impacts of shale gas development on benthic macroinvertebrate communities in streams. The information reinforced here suggests that the distribution of shale gas development areas and activities may be useful in predicting the quality of LOWA habitat, given the strong negative influence of these activities on the benthic macroinvertebrate community.

Topics: shale gas, LOWA, benthic macroinvertebrates, nesting success,
aquatic ecosystem health

Habitat Delivery

NE TX CONSERVATION DELIVERY NETWORK

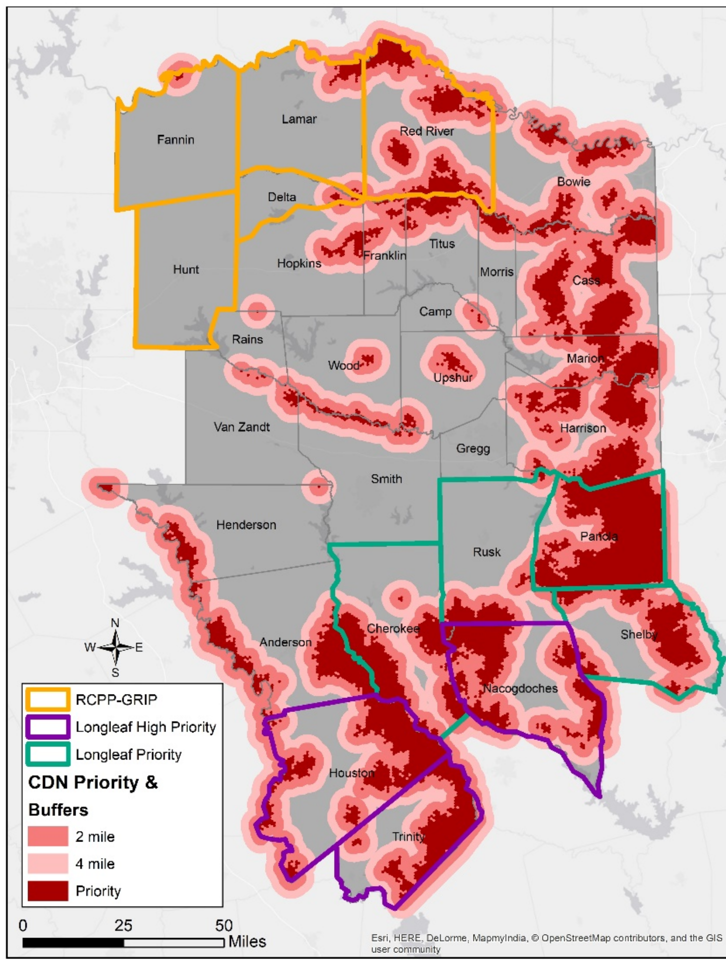
The Northeast Texas Conservation Delivery Network works to strategically meet the wildlife and landscape restoration and management objectives of its participating members.

Strategic Focus

Geography

Conservation action is promoted throughout the CDN geography, with highest priority placed on:

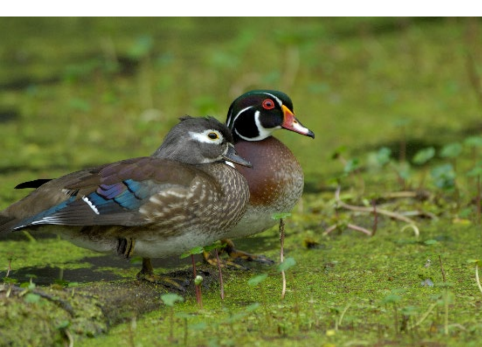
- Pine Savannah and Bottomland Hardwood habitat conservation within the red areas shown at right;
- Grassland habitat conservation within the five RCPP-GRIP counties outlined in gold; and
- Longleaf Pine conservation within counties outlined in green and purple.

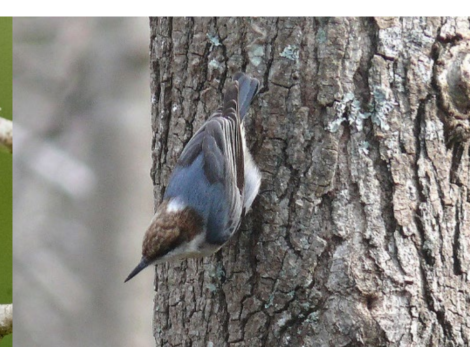


Action

Assisting partners (public and private) in achieving landscape-scale conservation objectives can take on many forms within the NETX CDN. Particular habitat treatments are tailored to specific needs. However, three pervasive activities throughout the region are:

- Establishment and management of native pine (**Longleaf and Shortleaf**);
- **Forest management towards desired conditions** for priority wildlife species; and
- **Prescribed Fire**



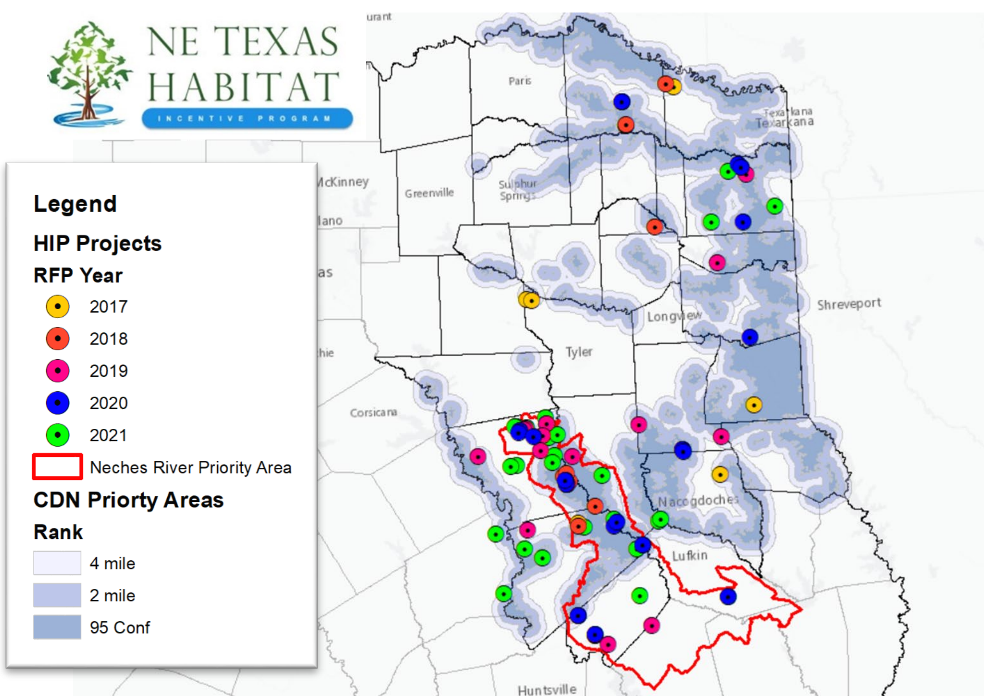


NE TX CONSERVATION DELIVERY NETWORK

CDN Habitat Incentive Program & Partners 2017-2021 (Completed)

YEAR	DOLLARS	ACRES
FY17	$187,599	942
FY18/19	$210,827	6,442
FY20	$140,215	3,543
FY21	$241,583	5,225
TOTAL	**$780,224**	**16,152**

Practice Distribution: 84% Rx Fire, 13% Chemical, 3% Timber Stand Improvement



NWTF Conserve. Hunt. Share.

Texas A&M Forest Service

Caddo Lake Institute

Texas Parks & Wildlife

NRCS

The Nature Conservancy Protecting nature. Preserving life.

Lower Mississippi Valley Joint Venture

U.S. Fish & Wildlife Service

NE TX CONSERVATION DELIVERY NETWORK

NETX CDN Partners

- Texas Parks and Wildlife
- Texas Forest Service
- National Wild Turkey Federation
- U.S. Fish and Wildlife Service
- The Nature Conservancy
- Caddo Lake Institute
- Natural Resources Cons. Service
- Oaks and Prairies Joint Venture
- Quail Forever/Pheasants Forever
- U.S. Forest Service
- Texas Natives (TAMUK)
- American Bird Conservancy
- Lower Mississippi Valley Joint Venture (Staff/Coordination)

Working Groups

- Red River
- Sulphur River
- Caddo/Cypress Basin
- Sabine River
- Neches River
- Trinity River
- Open Pine (Shortleaf)
  Conservation Award 10/2019
- Rx Fire
- Working Dogs for Conservation

Priorities and Initiatives

- CDN Habitat Incentive Program (HIP)
- Oaks and Prairies JV Grassland Restoration Incentive Program (GRIP)
- Texas Forest Service Rx Fire Grants
  - Community Protection Program
  - National Fire Plan
  - Neches River and Cypress Basin Watershed Restoration
  - Texas Longleaf Conservation Assistance Program
- Texas Longleaf Implementation Team (TLIT)
- Shortleaf Pine Initiative

Andy McCrady (TAMFS); 936-689-9393 — Chair

Reuben Gay (TPWD); 409-594-4845 — Vice Chair

Annie Farrell (NWTF) 903-539-0279 — HIP Administrator

Bill Bartush (ABC); 903-570-9626 — LMVJV Partnership Coordinator

www.lmvjv.org/ne-texas-cdn

CONSERVATION Wrangler
TEXAN by NATURE

Texas Longleaf Team (TLT)

Restoring Longleaf Pine in East Texas

EAST TEXAS

Texas Longleaf Team

THE LONGLEAF PINE ECOSYSTEM IS ONE OF THE SCARCEST PLANT COMMUNITIES IN THE SOUTHEASTERN UNITED STATES, WITH LESS THAN 3 PERCENT REMAINING IN THE SOUTHEASTERN LANDSCAPE AND ONLY 2 PERCENT OF THE ORIGINAL 3 MILLION ACRES REMAINING IN EAST TEXAS.

A well-managed longleaf pine savanna that includes frequent prescribed fire creates a diverse ecosystem that includes:

- Native understory grasses, forbs, trees, shrubs and vines that provide habitat for wildlife.
- Rare and endangered species such as the Red-cockaded Woodpecker, Bachman's Sparrow, Henslow's Sparrow, and the Louisiana Pine Snake.
- Game species such as the Eastern Wild Turkey, Northern Bobwhite Quail, American Woodcock, and many more.

Additionally, **fire-maintained longleaf pine forests use 15 percent less water than fire-excluded systems,** the diverse groundcover filters water more effectively, and the forest sequesters carbon longer than other southern pine species. Stewardship of longleaf pine forests can create diverse sources of income for forest landowners through forestry products, hunting and recreational leases, carbon trading, and other mitigation programs.

In 2010, the Texas Longleaf Taskforce was created to promote the restoration of longleaf pine on private and public forest lands in Texas. In 2014, the taskforce developed a steering committee of 15 conservation organizations known as the **Texas Longleaf Team (TLT)** to focus on East Texas longleaf pine restoration, specifically in the Longleaf Ridge and Big Thicket geographic areas. TLT, now 250 members strong, shares their passion for restoration of the longleaf ecosystem in Texas through landowner and industry outreach and education, technical support, and cost-share programs that assist landowners in implementation of prescribed fire, planting and other beneficial management practices.

BENEFITS OF LONGLEAF PINE RESTORATION IN EAST TEXAS

ENVIRONMENTAL BENEFITS

CARBON SEQUESTRATION
IMPROVED WATER QUALITY
WILDLIFE HABITAT

ECONOMIC BENEFITS

HIGH VALUE WOOD PRODUCTS
JOB CREATION
ENVIRONMENTAL RESILIENCE

HUMAN BENEFITS

HISTORIC RANGE RESTORED
CULTURAL IMPORTANCE
HEALTH BENEFITS

MISSION

The mission of the Texas Longleaf Team is to **promote the maintenance and restoration of the longleaf pine ecosystem on private and public forest lands,** including its cultural and economic values, through a collaborative network of diverse stakeholders and working groups.

IMPACT

- **Projected 115,000 acres** of enhanced longleaf pine, **30,000 acres** of maintained longleaf pine, and **15,000 acres** of newly established longleaf pine ecosystem by 2025.
- **1.03 million Texans** impacted with improved water quality, air filtration, and opportunity for economic benefits through conservation, water, and carbon offsets.
- **Carbon sequestered** much longer than other southern pine species due to its longer lifetime and height.
- **15% reduction in water usage** and better filtration due to fire maintenance and groundcover diversity of longleaf savannas. **Supplemental sources of income for landowners** through carbon trading, wildlife leases, mitigation opportunities, clean water and air, and biodiversity maintenance.

PARTNERS

TLIT is led by a steering committee comprised of representatives of the following partner organizations: Forest Resource Consultants, Hancock Timber Resource Group, International Paper, Lower Mississippi Valley Joint Venture, National Park Service, National Wild Turkey Federation, Resource Management Service, Texas A&M Forest Service, Texas A&M Natural Resources Institute, Texas Forestry Association, Texas Parks and Wildlife Department, The Nature Conservancy, T.L.L Temple Foundation, USDA Forest Service, USDA Natural Resources Conservation Service, and U.S. Fish and Wildlife Service.


Rob Billings of the Texas A&M Forest Service


Rachel Rommel

NEEDS

The Texas Longleaf Team was selected as a Texan by Nature Conservation Wrangler based on the project's positive impact to people, prosperity, and natural resources. Through the program, Texan by Nature and TLT are working together to address the following needs:

- **Diversification of funding** for cost-sharing with landowners to fuel increased longleaf pine restoration and management on private land in East Texas.
- **Expansion** of network of partners in TLT's geographically significant areas.
- **Quantification** of social, economic, and environmental benefits of longleaf pine restoration.
- **Enhanced** media visibility and brand continuity to improve the effectiveness of digital communications for a broader audience.

MAV Conservation Delivery Networks

Highlights since Jun 2 Management Board Meeting

Arkansas MAV CDN

Jun 21 - Steering Committee Planning Meeting (N. Little Rock)

Aug 17 - Membership Meeting (Brinkley)

- Theme: Desired Forest Conditions for Wildlife
- Attendance: 42
- Agenda Highlights:

  Field Trip

  ✓ Tour of DFCW Treatments on Dagmar WMA

  Meeting Presentations

  ✓Highlight - Five Oaks Ag Education & Research Center (Dr. Doug Osbourne/UAM)

  ✓MAV Forest Markets and Forest Certification (Jeremy Poirier, IP)

  ✓Forest Bird Habitat Objectives & DFCWs: Two Sides of the Same Coin (McKnight)

  ✓Project Spotlight:

  -Fall Water Bird Habitat Use in the MS Delta (Dr. Jason Hoeksema, U. of Miss)

  ✓Working Groups:

  -Tri-state Conservation Partnership Update (Brock/Seiss)

  -Delta Ag Lands Working Group Update (Brock)

Field Trip – Dagmar WMA, AR

LA/MS MAV CDN

Jun 9 - Steering Committee Planning Meeting (Omega, LA)

Jul 29 - Membership Meeting (Vicksburg, MS)

- Theme: Desired Forest Conditions for Wildlife
- Attendance: 41
- Agenda Highlights:
  - ✓Partner Spotlight: Quail Forever (Austin Klais/LA & John Mark Curtis/MS)
  - ✓MAV Forest Markets and Forest Certification (Jeremy Poirier, IP)
  - ✓DFCW & Bottomland Hardwood Plantation Management - Buddy Dupuy, LDWF
  - ✓Delivering DFCW on Private Lands - Jeff Denman, Private Forestry Consultant
  - ✓Panel Question and Answer – Poirier/Locascio/Denman
  - ✓Working Group & Organizational Updates:
    - -NRCS Update (Dustin Farmer, LA NRCS)
    - -Tri-state Conservation Partnership (Seiss/Brock)

TRI-STATE CONSERVATION PARTNERSHIP

Mail Insert - WRE Management Videos

To be sent to WRE landowners in AR, LA & MS along with a thumb drive containing 7 videos (note: Red QR Code and Youtube link in this draft version are not active)

Front:

Back:

Looking Ahead

Looking Forward

LMVJV – Significant Information Synthesis/Development Capacity Challenges

The LMVJV Management Board is asked to consider how we, as a partnership, best address information and capacity needs regarding issues of extreme importance to achieving the Goals and Objectives of the LMVJV. Following are the four issues (in no particular order) presented briefly at the Spring 2021 Board Video Call:

(1) Avian Science
(2) Climate Science
(3) Hydrology
(4) Social Science

For each issue a brief summary of Why?, How?, Who?, and When?, is provided in **Appendix A**. What follows is a treatment of this "decision challenge", applying principles of strategic decision making (SDM).

2 Basic Levels of Decision

(1) **Issue Identification**: Are these the best issues to consider? Are there others? What is the best prioritization of them?

(2) **Issue Resolution**: Within each issue, what is the best solution?

1. Issue Identification

Framing the Problem

Problem: Ensure that the Board applies its effort towards the most important issues

Decision maker: LMVJV Management Board

Legal & Regulatory contexts: USFWS Manual 721 FW 6 establishes policy guidance for the organization of joint ventures receiving administrative funding through the Service. Hence, the LMVJV has the responsibility of implementing national and international bird conservation plans within it's specific geographic area, through activities that include biological planning and prioritization; project development and implementation; monitoring, evaluation, and applied research activities; communications and outreach; and fund raising for projects and other activities.

Scope & Scale: LMVJV administrative region (BCRs 25 &26)

Timing & Frequency: No real deadline, but time lost in action is opportunity lost; no natural frequency, beyond this decision point

Uncertainties: Future issue-specific funding opportunities/sources that may or may not hinge on this capacity or the products expected from this capacity; Relative impact of poor information/not having capacity to adequately address the issues; Completeness and/or appropriateness of "Big 4" list of issues

Other, Linked Decisions: Capacity and information investments by and within partner organizations; LMVJV spending on direct science projects

Objectives

Fundamental Objective - Position the LMVJV such that the partnership can reasonably understand, apply, and provide input and/or leadership towards the major drivers of landscape function and change that impact conservation of priority birds and their habitats

Means Objective – Focus Management Board time and energy on resolving only the most important/impactful issues

Potential Actions

- Accept the four proposed issues
- Add an issue(s) to the four proposed
- Accept a subset of the four proposed issues
- Accept a subset of the four proposed issues, plus additional issue(s)
- Conclude that no big issues (as proposed) are worth addressing

Suggested Issue Identification Methodology

Solicit additional issue suggestions from Management Board. Request that Management Board members rank these issues from 1 (lowest priority) to 4 (highest priority) [or max number of issues if more than 4]; calculate the collective ranks using simple means; seriously question pursuing any issue with a mean of ≤1.5. Results of this exercise to be used in 27 October 2021 discussion. ("Vote" solicitation form distributed to Board with notebook)

2. Issue Resolution

Framing the Problem

Problem: The LMVJV is unable to adequately understand and address several drivers of landscape change in the context of bird habitat, as a partnership, due to lack of coordination and synthesis capacity. These drivers have a profound, but poorly understood, impact on bird habitat quantity and quality, and on the partners' ability to carry out appropriate conservation measures.

Decision maker: LMVJV Management Board

Legal & Regulatory contexts: USFWS Manual 721 FW 6 establishes policy guidance for the organization of joint ventures receiving administrative funding through the Service. Hence, the LMVJV has the responsibility of implementing national and international bird conservation plans within it's specific geographic area, through activities that include biological planning and prioritization; project development and implementation; monitoring, evaluation, and applied research activities; communications and outreach; and fund raising for projects and other activities.

Scope & Scale: LMVJV administrative region (BCRs 25 &26)

Timing & Frequency: No real deadline, but time lost in action is opportunity lost; no natural frequency, beyond this decision point

Uncertainties: Future issue-specific funding opportunities/sources that may or may not hinge on this capacity or the products expected from this capacity; Relative impact of poor information/not having capacity among the issues;

Other, Linked Decisions: Capacity and information investments by and within individual partner organizations; LMVJV Office spending on direct science projects;

Objectives

Fundamental Objective - Position the LMVJV such that the partnership can reasonably understand, apply, and provide input and/or leadership relative to the major drivers of landscape function and change that impact conservation of priority birds and their habitats

Means Objectives – (1) Identify the most reasonable approaches to filling important capacity gaps, utilizing all reasonable options (e.g., expenditure of USFWS 1234 funds, increased partner contributions, grants & other soft money, shared positions, etc.); (2) Agree upon roles, responsibilities, and next-steps among JV partners and staff; (3) establish a timeline for achieving desired results.

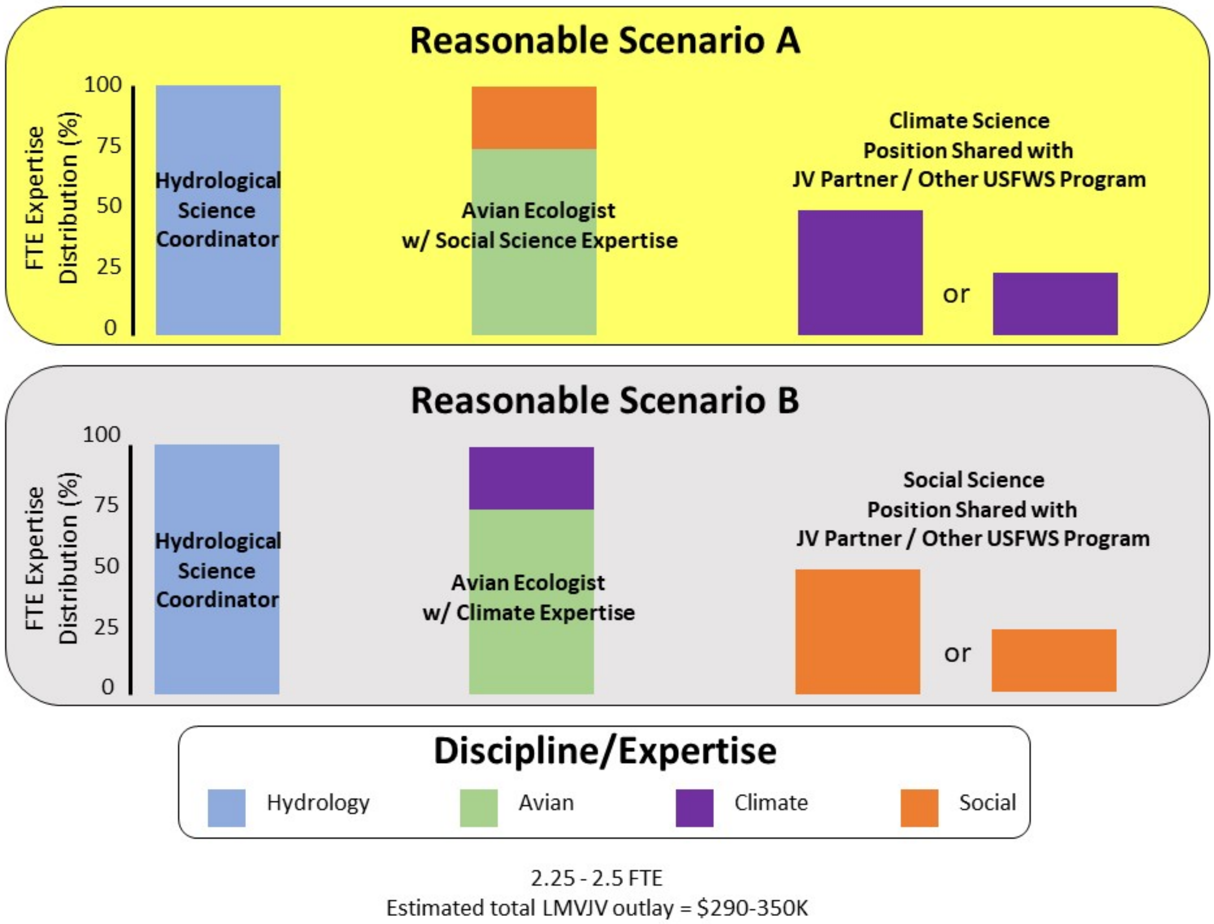
Potential Actions

- Status quo
- Re-direct LMVJV Office Funds currently spent on "science projects" (approx. $100K annually) to address some portion of identified capacity needs
- Cost-share positions among JV partners (including USFWS non-Mig Bird Programs) & JV Office
- Cost-share positions among neighboring JVs
- "Bundle" needed expertise within a single FTE (e.g., avian ecologist with social science expertise)
- Various combinations of the above

Suggested Issue Resolution Methodology

- Gather as much information as possible, prior to October 2021 Board meeting, regarding potential sources of funding, need/desire for cost-shared capacity, shared desire for capacity among partners, etc.
- Fully discuss each capacity challenge, its relative impact on JV objectives, and possible solutions at October 2021 Board meeting
- Settle on clear next-steps for addressing the challenges, prioritized as necessary and appropriate.

Figure 1. Graphic depiction of reasonable scenarios regarding means of addressing various potential capacity needs. These scenarios are meant to facilitate thought and discussion.



<u>Potentially Relevant Thoughts, Angles, Opportunities to Consider</u>

- Potential role of RAWA
- Better utilize the rich capacities of USGS. Recently, USGS contribution has been a "pay-to-play" proposition. Does the 2021 USGS Landscape Science Strategy's focus on "partnership" imply that this will be less the case moving forward?
- Share staff with partner agencies. Is this possible? Is this desirable?
- Share staff with neighboring JVs. Is this desirable?
- What is the probability (and magnitude) of increased 1234 funds in the near future?
- Are there potential corporate partners with a natural LMVJV nexus that we should engage for monetary support?
- Mississippi River Restoration & Resilience Initiative (MRRRI; PROPOSED) potential to contribute? [https://mccollum.house.gov/mississippi-river-restoration-and-resilience-initiative-mrrri]
- Others…

APPENDIX A

BIG 4 HORIZON ISSUES

Following are brief descriptions of four science/information capacity needs of particular relevance to the mission of the LMVJV. These are intended to begin a discussion among the Management Board and Staff, which we intend to more fully address at the Fall 2021 Management Board meeting. Specific questions surrounding these topics are not so much "are they important issues", rather "what (if any) is the LMVJV's role in actively addressing them", "how do they compare in priority" and "where/how might we secure the resources necessary to address them"?

Avian Science

Why?

The foundation of our partnership is bird habitat conservation. The LMVJV Mission speaks to developing, implementing, and refining a shared vision of bird conservation. Priority actions in pursuit of this mission dovetail well with numerous other important conservation goals (e.g., climate adaptation, water conservation, social benefits, etc.). However, to understand, quantify, and effectively deliver on these areas of true nexus, our Bird Science must be solid and current.

How?

Ensuring that the LMVJV's foundational science for bird conservation is optimally developed and kept current (relevant) requires effective science coordination across each sub-discipline of waterfowl, songbird, shorebird, waterbird, and bobwhite ecology and management, with an understanding and sensitivity to their nexus with the other disciplines outlined below, AND ample time to do the job well.

Who?

As with all aspects of science important to LMVJV priorities and objectives, the majority of work is accomplished through partnership, by partners. A key ingredient in that recipe for the LMVJV over the past three decades has been provision of dedicated JV Office Staff capacity to plan, organize, communicate, coordinate, and facilitate action by our partner staff in developing products (decision support tools, conservation plans, communications tools, etc.) appropriate to support our mission. Placing responsibility on a single individual for remaining current in the science, networking with the scientists, initiating and completing contemporary plans/tools/objectives, and publishing these results across all bird guilds and taxa in an efficient and effective manner is unrealistic. Splitting the primary Bird Science coordination responsibilities among two JV Office Science Staff is optimal, if timely and effective progress is to be made and maintained over time.

When?

This capacity should be added as soon as feasible.

Climate Science

Why?

Climate, soil, and disturbance are the ultimate drivers of ecological community composition and function. Hence, changes in climate impose significant impacts on habitat. Importantly, confidence in the predicted trajectory of important climatological changes within a given geography is essential if conservation actions are to be tailored to fit and/or dampen that trajectory. Within the LMVJV geography, the choice of which model(s) is applied can have a significant effect on not only the severity of forecasted impacts, but even the direction of the trajectory of some variables. For this reason, informing and/or adjusting LMVJV bird population and habitat objectives using climate change predictions has been, and continues to be, problematic.

However, the current political and funding environment increasingly places a premium on the ability to express goals, objectives, and expected outcomes in terms of climate-related benefits and accommodations. The LMVJV's standing in this regard (political support, financial support, etc.) will be improved in direct proportion to our ability to demonstrate a nexus with and communicate our priorities and actions in connection to climate change.

How?

Using recent, accepted, published work, the LMVJV can begin by cataloguing plausible climate-positive equivalents (e.g., sequestration rates, connectivity, etc.) for our most prevalent priority actions (reforestation, wetland restoration, forest management). Beyond this, if the partnership's decision support tools are to be informed by climate science, partner consensus on the most plausible climate change models (or suite of models) and parameters will be necessary. Outputs from these predictive models can then be used to inform the relevant features of our habitat models.

Who?

As with all others aspects of science important to LMVJV priorities and objectives, the majority of work will be accomplished through partnership, by partners. Close association of the Migratory Bird and Science Applications Programs in USFWS, Interior Regions 2 & 4 likely can facilitate the LMVJV's access to significant technical capacity regarding climate change and related model application. However, doing this in an effective and efficient manner will require additional JV science coordination capacity.

When?

Some cursory "equivalents" are easily obtained from the literature (e.g., carbon sequestration rates for afforestation in the MAV). However, a more thorough synthesis of existing literature, practices, etc. will require focused attention and investment of time. Pursuing questions of climate change, its nexus with LMVJV priorities, and specifically applying these to our habitat objectives, priorities, and models in a timely and effective manner will require at least some degree of additional dedicated science coordination capacity.

Hydrology

Why?

Terrestrial conservation issues connected to water are significant and numerous within our geography. While not exclusive to lowlands, the most pervasive and easily-understandable water issues relate to impacts upon bottomland hardwood habitat – both in the MAV and WGCPO. From reservoir development to prolonged flooding to drying of once-wet surface and subsurface layers, the LMVJV's collective understanding of the ecological and sociological drivers, consequences, and possible solutions to changed/changing hydrological patterns will greatly impact our ability to conserve these systems for birds.

How?

Making useful progress in this arena will require a comprehensive synthesis of what is already known, coupled with a short list of priority actions necessary to fill in critical knowledge gaps, then working to fill the gaps. This synthesis, identification and closing of gaps applies equally to the science and policy of water (surface and subsurface).

Who?

As with all others aspects of science important to LMVJV priorities and objectives, the majority of work will be accomplished through partnership, by partners. However, doing this in an effective and efficient manner will require additional science/information coordination capacity, no different from the way we address bird biology and delivery questions.

When?

Preliminary effort (2016 SEAFWA) was initiated to begin scoping issues relevant to floodplain hydrological challenges. Whereas investigations into these issues have continued throughout the LMVJV geography and beyond by scientists (USGS, LSU, etc., etc.), no concerted effort has been applied to a useful synthesis and focused effort(s) by the LMVJV.

Pursuing an actionable, broad-scale understanding of floodplain hydrology (science, and informing policy) as a partnership will require additional dedicated science and information coordination capacity.

Social Science

Why?
Human behavior/attitude factors strongly influence conservation success. Understanding the primary drivers of decision-making surrounding important conservation actions is the first step to increasing our reach and effectiveness.

How?
We must work as partners to identify the most important (assumed) limiting factors in understanding and applying solutions to attitudinal/behavioral hurdles to achieving LMVJV objectives. Following this, we must then secure appropriate resources for addressing the questions, then practically apply this new/refined understanding to delivery.

Who?
As with all others aspects of science important to LMVJV priorities and objectives, the majority of work will be accomplished through partnership, by partners. However, doing this in an effective and efficient manner will require some level of additional science coordination capacity, no different from the way we address bird science now.

When?
Preliminary effort (Nov 2019) has already begun with respect to scoping priority human dimensions issues that impact achieving our waterfowl objectives. Revision of the LMVJV waterfowl energetics model and objectives in 2022 will utilize application of social science. In a similar way, partners have begun applying basic social science theory, principles, and approaches to better understanding landowner adoption of important practices within Open Pine ecosystems in Arkansas and Louisiana (Morehouse Family Forest Initiate), with expanded effort planned outside the 8 MFFI counties/parishes in 2022-26 through RCPP. The 2018 Organizational Plan priority of piloting an effort to use existing public land-use information (monitoring data) to synthesize, analyze, and understand numerical response of humans to management actions on appropriate state Wildlife Management Areas has not yet begun.

Pursuing social science questions in a timely and effective manner will require at least some additional dedicated science coordination capacity.

	LMVJV Priority Bird Species	LMVJV Planning
✓	American Bittern	NONE[1]
	American Kestrel - Southeastern	Open Pine Bird Plan
✘	American Woodcock	NONE[3]
	Bachman's Sparrow	Open Pine Bird Plan
➔	Bewick's Wren	NONE[3]
	Brown-headed Nuthatch	Open Pine Bird Plan
	Buff-breasted Sandpiper	Shorebird Plan
	Canvasback	Waterfowl Plan
	Cerulean Warbler	MAV Forest Breeding Bird Plan
➔	Chuck-will's-widow	NONE[3]
	Dunlin	Shorebird Plan
👍	Eastern Meadowlark	NONE[4]
➔	Eastern Whip-poor-will	NONE[3]
👍	Field Sparrow	NONE[4]
👍	Grasshopper Sparrow	NONE[4]
	Henslow's Sparrow	Open Pine Bird Plan
	Kentucky Warbler	MAV & WGCPO Forest Breeding Bird Plans
✓	King Rail	NONE[1]
	LeConte's Sparrow	Open Pine Bird Plan
	Lesser Scaup	Waterfowl Plan
	Lesser Yellowlegs	Shorebird Plan
✸	Little Blue Heron	NONE[1]
	Northern Pintail	Waterfowl Plan
	Pectoral Sandpiper	Shorebird Plan
	Prairie Warbler	Open Pine Bird Plan
	Prothonotary Warbler	MAV & WGCPO Forest Breeding Bird Plans
	Red-cockaded woodpecker	Recovery Plan & LMVJV Open Pine Plan
	Red-headed Woodpecker	Open Pine Bird Plan & MAV Forest Breeding Bird Plan
	Rusty Blackbird	MAV & WGCPO Forest Breeding Bird Plans
	Semipalmated Sandpiper	Shorebird Plan
	Short-billed Dowitcher	Shorebird Plan
	Swallow-tailed Kite	MAV Forest Breeding Bird Plan
✸	Wood stork - Southeastern (AL, FL, GA, MS, NC, SC	NONE[3]
➔	Wood Thrush	NONE[2]
✓	Yellow Rail	NONE[1]
➔	Yellow-billed Cuckoo	NONE[2]

6 In Progress

✓ **Secretive Marshbird**
👍 **S. Grassland Coop.**

36% of species not yet addressed
19% of species not started

7 Not Addressed

✸ **Colonial Waterbird**
➔ **Upland Hardwood**
✘ **Special Focus**

Desired Characteristics for Habitat Joint Ventures

a

...actively work to **broaden the external partnership** with relevant individuals and organizations.

a,b

...strong professional contacts and connections, networking to **keep the JV abreast of current conservation issues**...

a,b

...works with partners to **address any missing capabilities**...

a

Technical expertise needs are identified.

a,b

Technical expertise for **specific bird conservation needs...improving the science** of the JV...

a Especially relevant to hydrology, HD, and/or climate capacity
b Especially relevant to avian science capacity

Element	Sub Element/ Product	TECHNICAL EXPECTATIONS Minimal Content- Expected characteristics and level of performance for newly established and/or minimally-funded Joint Ventures*.	Comprehensive Content- Joint Ventures* should move toward this content as a Joint Venture matures and funding levels increase.
ORGANIZATIONAL PERFORMANCE	Coordination/ Partnerships	Joint Venture* develops a vision for the Joint Venture's future; establishes and implements strategies to achieve that vision. Joint Venture develops and maintains strategic regional alliances, consistent with the Joint Venture's mission. Joint venture office provides leadership to develop, with the Management Board**, a strategic implementation plan to define and achieve the goals of the partnership.	Joint venture office and Management Board actively work to broaden the external partnership with relevant individuals and organizations. Joint Venture maintains strong professional contacts and connections, networking to keep the Joint Venture abreast of current conservation issues, techniques, etc. Joint venture office identifie partner capabilities to address the Joint Venture mission and works with partners to address any missing capabilities through additional staff, partners, contracts or training appropriate to the size and complexity of the Joint Venture region. The Join Venture participates in development of common joint venture messages to Congress and other relevant national entities and cultivates informational relationships with it Congressional delegation and staff. Management Board coordinates on congressional outreach with other Joint Ventures.
	Management Board	Joint venture office supports operations and administration of Management Board by advising and informing Board members. Management Board has broad representation within the Joint Venture geographic region (Fed, State, Non-Profit, Private) and members regularly participate in meetings. Member organizations commit energy and resources to developing a shared vision of bird conservation for the Joint Venture and coordinate their otherwise independent actions in the cooperative pursuit and refinement of that vision.	Management Board members bring significant resources to the Joint Venture, engage in current issues facing the Joint Venture, share responsibilities for Joint Venture progress, follow through on commitments and responsibly use their influence for the betterment of the Joint Venture. Management Board develops and adopts a process for periodic self assessment that includes relevant goals and metric for both programmatic and organizational performance.
	Budgeting/ Granting/ Administration/ Funding	A financial management system is in place. Administrative support is available to the joint venture office/staff either directly or through joint venture partners. Mechanisms exist to receive and expend federal funding in compliance with OMB Circular A-133. Joint venture office keeps the Management Board fully informed on the status of the joint venture office's operations and finances. Joint venture office maintains working knowledge of pertinent funding opportunities. Joint venture office works with partner organizations to obtain grants and other funds to implement priority conservation actions.	Joint Venture financial system is sophisticated enough to manage grant/contract funds as appropriate. Administrative personnel are on or available to Joint Venture staff. Joint Venture has grant-writing capacity available in staff and or partner organizations. Joint Venture seeks and attracts funds from a broad range of traditional and non-traditional conservation programs and other funding sources to implement priority bird conservation actions. Joint Venture develops and implements fundraising strategies for approaching and cultivating new sources of major support, including foundation and corporate grant programs, and partner contributions. Working with the Management Board, joint venture office directs the preparation of annual and long-range development planning.
	Technical Community	Technical expertise needs are identified. Joint Venture has access to technical staff either directly or through partnership.	Joint Venture has science coordinator(s), geospatial technician(s), and other science expertise on staff or available through partners as appropriate to the size and complexity of the Joint Venture region. Technical committees for specific bird conservation science needs are in place as needed with full participation from partnership organizations. Technical committees are improving the science of the Joint Venture.

Desired Characteristics for Habitat Joint Ventures

Element	Sub Element/ Product	**Technical Expectations** Minimal Content- Expected characteristics and level of performance for newly established and/or minimally-funded Joint Ventures*.	Comprehensive Content- Joint Ventures* should move toward this content as a Joint Venture matures and funding levels increase.
BIOLOGICAL PLANNING	Coordination/ Partnerships	Joint Venture leads a collaborative effort, often through a technical committee appointed by the Management Board, to build a biological foundation of bird conservation needs that is both based on, and informs international, national, or regional bird conservation initiatives.	Joint venture partners seek opportunities and venues to integrate Joint Venture biological planning with relevant work of their agency/organization and with the relevant work of other agencies and organizations active within the Joint Venture area. Priority examples include state wildlife action plans, National Wildlife Refuge Comprehensive Conservation Plans, The Nature Conservancy (TNC) Ecoregional Plans, US Fish and Wildlife Service (FWS) Migratory Bird Focal Species plans, and National Fish and Wildlife Foundation Keystone initiatives.
	Biological Planning Unit (Spatial and Temporal Scales)	Biological planning unit(s) is(are) defined. Identify temporal importance (breeding, staging, wintering) of the Joint Venture region to migratory birds. Explain and justify when planning scale deviates from bird plan conservation ecoregions.	Biological planning units identified at Bird Conservation Region (BCR) or sub-BCR scales. Explicit treatment of overlapping planning units within multiple Joint Venture administrative boundaries (if any).
	Priority Species	A preliminary list of priority bird species or suites of species are identified and justified.	Complete list of priority bird species/populations, considering all relevant FWS Birds of Management Concern. Explanation if priority species/populations deviate from priorities in latest bird plan updates. A subset of species may be identified that represent the larger set of priority species for detailed biological planning and conservation design.
	Population Objectives	Anticipated population objective variables (abundance, vital rates, etc.) identified. General description of the process that will likely be used to develop population objectives. Description of how those objectives will link to bird plans' continental objectives.	Explicit population objectives are identified. Flexible population objectives identified as appropriate to account for environmental or seasonal variability. Documentation of the process for deriving population objectives and identification of major sources of uncertainty.
	Limiting Factors	A list of potential factors thought to limit birds in the biological planning unit(s) used.	Demographic parameters for target species (e.g., survival rate, recruitment rate) thought to be most limiting to population objectives are targeted by habitat management actions.
	Species/Habitat Relationships	Discussion of population-habitat model(s) expected to be developed to relate population response to known or suspected limiting factors (e.g. empirical, conceptual).	Explicitly stated population-habitat models. Assumptions documented as testable hypotheses.

Population objectives for priority species… *b*

Limiting demographic factors identified for priority species… *b*

Explicitly stated population-habitat models. *b*

a Especially relevant to hydrology, HD, and/or climate capacity
b Especially relevant to avian science capacity

Desired Characteristics for Habitat Joint Ventures

a

…**forecast expected carrying capacity** with and without partnership intervention and **predict impact of expected major changes**…

a,b

Assessment of the net change in the conservation landscape…conducted at **<5 year** intervals.

a,b

Spatially-explicit decision support tools… overcome **limiting factors**.

b

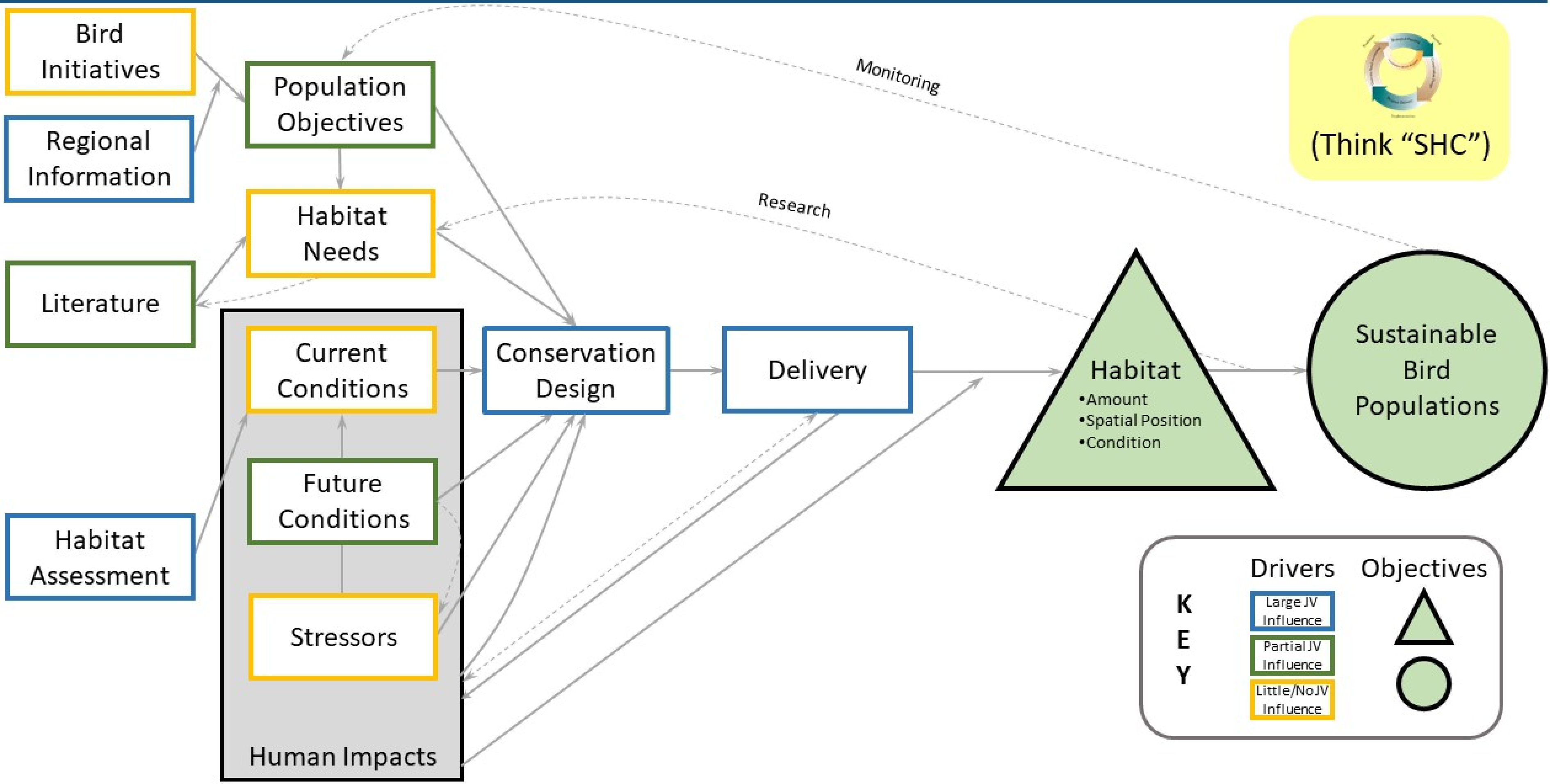
…integrating habitat objectives and **spatial priorities for all priority species/groups** and management treatments.

Element	Sub Element/ Product	TECHNICAL EXPECTATIONS Minimal Content- Expected characteristics and level of performance for newly established and/or minimally-funded Joint Ventures*.	Comprehensive Content- Joint Ventures* should move toward this content as a Joint Venture matures and funding levels increase.
CONSERVATION DESIGN	Coordination/ Partnerships	Commitment of Joint Venture to develop technical capabilities and planning tools for conservation design.	Joint Venture develops and implements strategies to utilize science products to better target and enhance conservation programs at the ecoregional level to benefit migratory birds. Joint venture office and/or Management Board members build strong relations with decision makers in state and federal institutions, private industry, and partner organizations to strengthen their understanding of the Joint Venture's conservation activities and capabilities.
	Landscape/ Habitat Characterization and Assessment	General description of Joint Venture's ecological setting relative to bird habitat. List of major drivers impacting bird habitat with links to assumed limiting factors and population-habitat relationships. Set of implications to bird population in the absence of partnership intervention.	A rigorous analysis of landscape/habitat carrying capacity based on explicit population-habitat models. Where possible, conduct retrospective analysis of carrying capacity (e.g., prior to 1986). Where possible, forecast expected carrying capacity with and without partnership intervention and predicts impacts of expected major changes (e.g., urban growth, climate change).
	Assessment of the Conservation Estate	Preliminary summary of bird habitat (acres) protected, managed, and restored in the planning unit. This includes an assessment of all conservation lands that will benefit birds.	Thorough analysis of existing bird habitat under protection, management, or enhancement throughout the biological planning unit. Information should be presented by ownership, state, etc. where applicable. Assessment of the net change in the conservation landscape since the inception of the Joint Venture conducted at <5 year intervals.
	Decision Support Tools	Description of how the Joint Venture might develop decision support models/tools to guide specific management actions suitable to overcome limiting factors. If deemed appropriate, develop a set of spatially-explicit focus areas to guide interim conservation delivery activities.	Spatially-explicit decision support tools for specific management actions suitable to overcome limiting factors are available. Tools distributed to partnership based on population-habitat models where appropriate. Documented analytical processes and model assumptions.
	Habitat Objectives	General estimation of the magnitude of habitat protection, restoration, and enhancement that might be expected of the Joint Venture.	Explicit set of habitat objectives linked to population objectives and based on population-habitat models, carrying capacity, assessment of conservation estate, and decision support models as available. Habitat objectives should be partitioned among sources of habitat (ownership, state) where appropriate.
	Integration of avian decision-support tools	Articulate anticipated approach for integrating habitat objectives among species-groups, habitat types and management treatments for priority avian species/groups.	Develop tools for integrating habitat objectives and spatial priorities for all priority species/groups and management treatments. Describe decision-rules for conflict resolution. Describe extent of spatial/temporal overlap in conservation activities.

a Especially relevant to hydrology, HD, and/or climate capacity

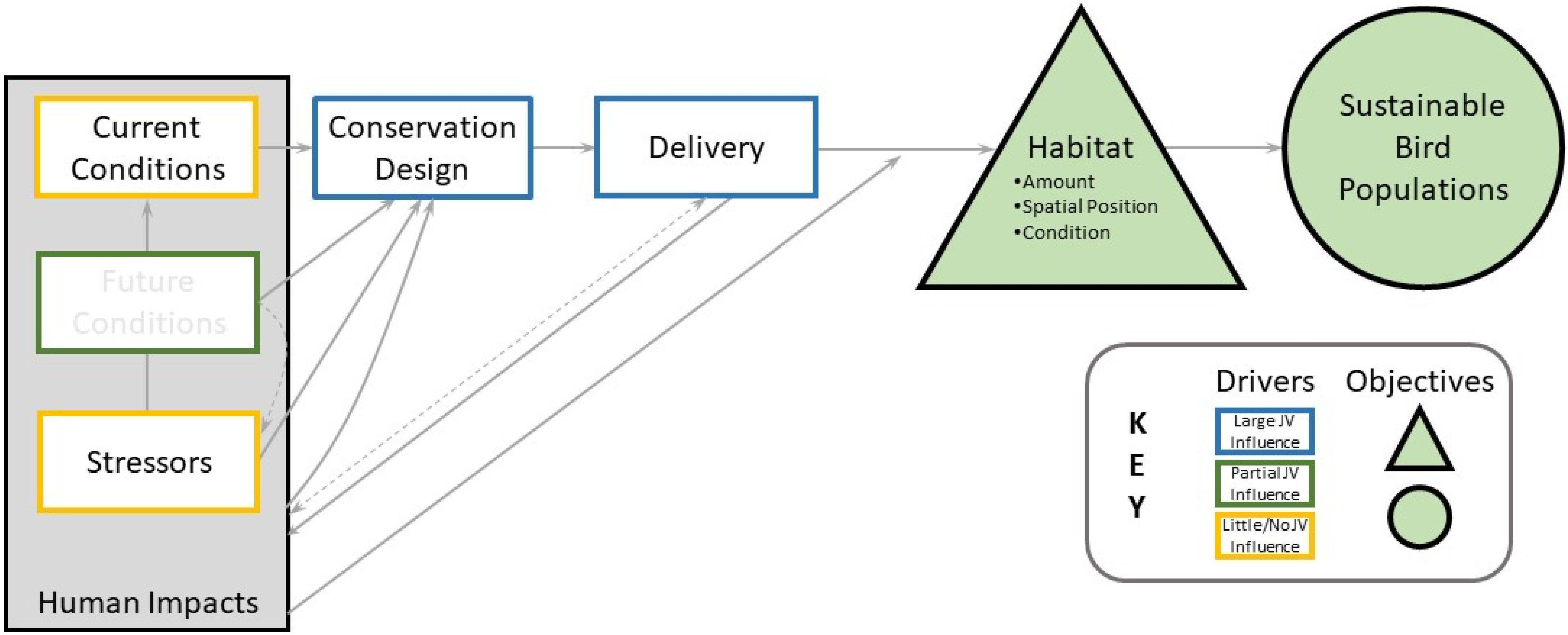
b Especially relevant to avian science capacity

Fundamental JV Business



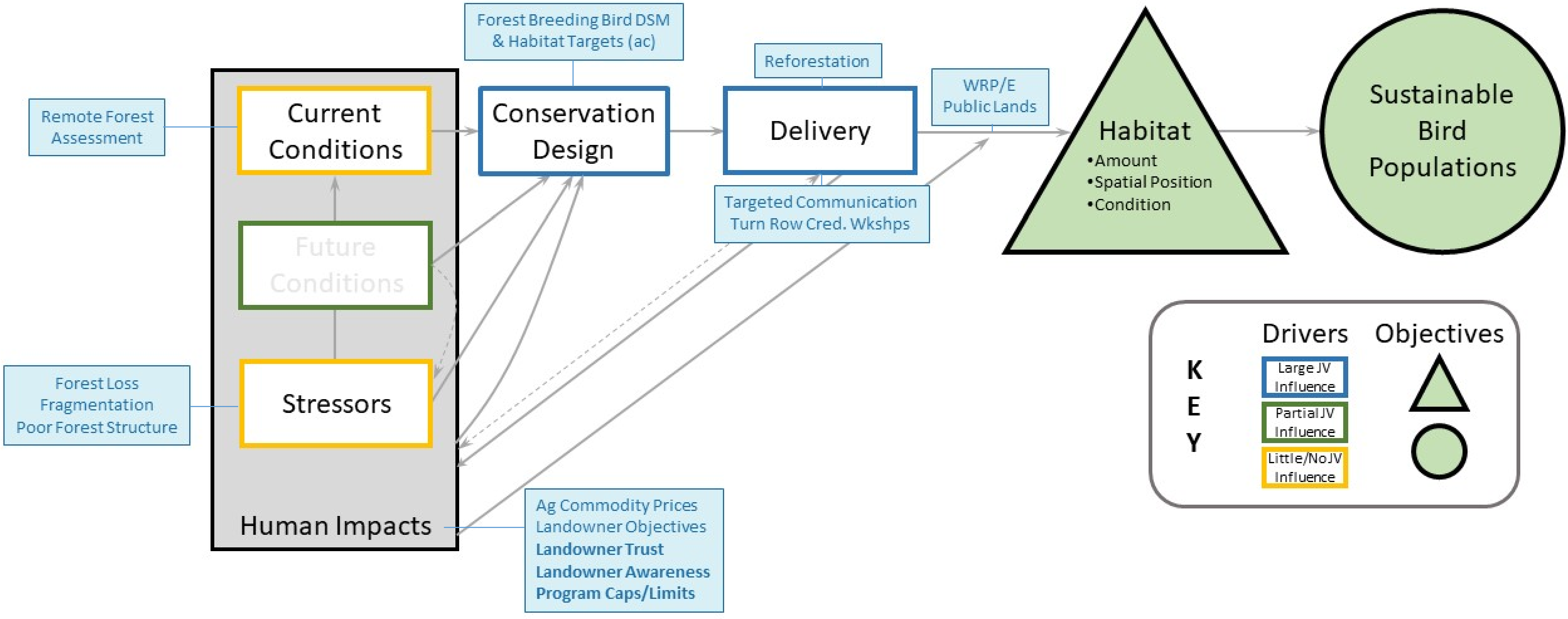
Fundamental JV Business

Current Status - Simplified



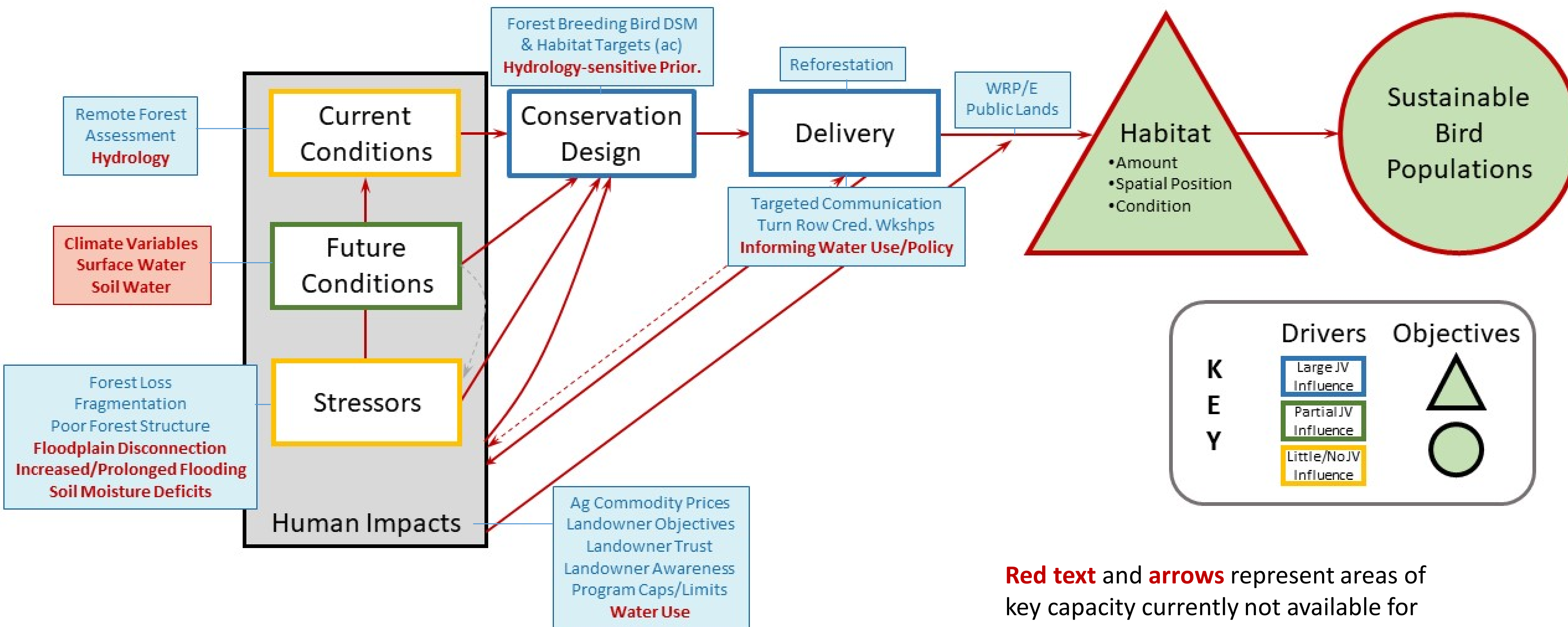
MAV Forest Restoration – Forest Breeding Birds

Current Status - Simplified



MAV Forest Restoration – Forest Breeding Birds

Ideal



Red text and **arrows** represent areas of key capacity currently not available for synthesis and application at the JV scale.