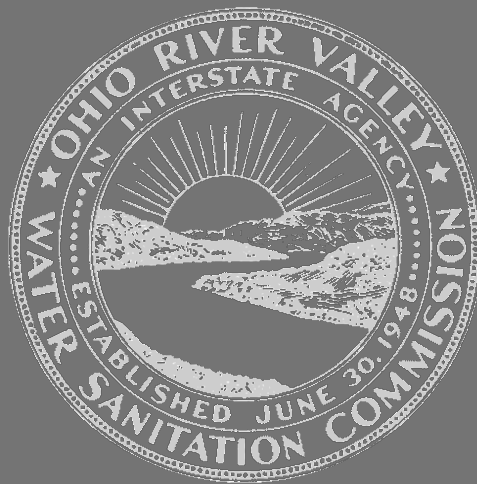


2014

Interbasin Transfers of the Ohio River Basin

Water Resources Initiative

The goals of this report is to provide a quantifiable estimate of water lost via interbasin transfers, the regulatory policies in place, the role of agencies / commissions, and the potentially vulnerable areas with limited or no regulations or at risk for unsustainable / increasing water withdrawals.



Interbasin Transfers of the Ohio River Basin



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Background

Interbasin transfers (IBTs) are defined as water that is transferred or diverted from a defined watershed basin to another. An IBT is primarily recognized as a diversion of surface water sources however groundwater diversions do occur but can be more difficult to identify. IBTs have been viewed as a controversial water management practice particularly in cases where a lack of stewardship is recognized for downstream users. The majority of any basin's population is likely to be located downstream of another and consequently influences those communities and water users. The removal of water from a basin via consumptive loss or IBTs can negatively impact flows and adversely affect downstream water users. The source watershed of an IBT could potentially experience decreased stream flows and potentially augmenting the drought effects.

Water resource managers are often faced with the challenge of managing waters to reduce conflicts between upstream and downstream users. Accomplishing the water management goals requires a balance between the designated uses and water demands within a defined system. These water management practices can interfere with water managers' ability to meet specific water demands at downstream control points. Therefore many state agencies have policies in place regarding these practices to monitor, regulate, and account for the amount of water lost from a system. In some cases interstate basin commission agencies have regulatory policies (that are typically enforced/implemented/permitted by state agencies) established to protect the water resources for the watersheds that the commission(s) represent.

Water transfers between major river basins (and considered as IBTs) can be transported via pipelines, water-hauling trucks, and/or canals and varies according the end-water-use needs and associated demands. Municipal diversions and resource extractions typically transport water using pipelines and trucks. Canals are typically used for recreational and commercial navigation. Despite the existence of negative connotations, IBTs can be successfully managed with the implication of responsible and appropriate safeguards and limitations. If these IBTs are not closely monitored and/or regulated, it could adversely affect the sustainable water-use within a watershed.

The value of the water resources in any river basin is worth more than the summation from its integrative network of quantifiable parts. A monetary value can be placed on its economic, commercial, private, and recreational portions but not the value sought in its unquantifiable aesthetics, ecological benefits, society gains, and historical and cultural values. Regardless of the immeasurable values, the physical extraction of water should be considered like any other extractable natural resource. In contrast to mineral resources where extraction is permissible by private land-owners, water extraction is typically permissible without proprietary ownership; therefore considered a resource (or property) of the state. It is the responsibility of a state's agency to govern its withdrawals and uses within its political boundaries. However, the governance of waters extending beyond political boundaries requires a watershed approach for the protection of water quality and quantity in a basin. This approach has warranted

'You could write the story of man's growth in terms of his epic concerns with water.'

- Bernard Frank

the establishment of interstate basin commissions. The collaborative dynamics between state and interstate agencies facilitate the protection of the resource for designated-uses and demands.

Objective

Presently within the Ohio River Basin, IBTs do occur however estimations of the total volumes are relatively small. The most common IBTs are municipal transfers that occur in isolated areas where communities straddle the boundaries of the ORB. In recent years, there has been an increase in the amount of IBTs for the oil and gas industries to aid in the process of extracting resources. The goals of this report is to provide a quantifiable estimate of water lost via IBTs, the regulatory policies in place, the role of agencies/commissions, and the potentially vulnerable areas with limited or no regulations or at risk for unsustainable/increasing water withdrawals.

Study Area

Interbasin transfers are defined as surface waters that are transferred or diverted from a defined watershed basin to another. The recognition of a basin by governing entities can be subjective but is usually recognized using 2-, 4-, or 8-digit Hydrologic Unit Codes (HUC level). The Ohio and Tennessee River basins are recognized at the 2-digit HUC level however the Tennessee River enters the Ohio River at river mile 933 near Paducah, KY. This is 46 miles upstream from the Ohio River's mouth with the Mississippi River at river-mile 981. For the purposes of this report, the ORB is recognized to include the Tennessee River basin. The border (or perimeter) of ORB extends 3,782 miles in length and borders 13 major river basins (Table 1; Figure 1). This extensive perimeter offers ample opportunities for the transfer of water between basins. Of the 14 states within the basin, there is not a single state that has its land area fully encompassed within the ORB.

Table 1. The total perimeter length the Ohio River basin approximates 3,782 miles and the border lengths of 13 major neighboring basins are provided.

Bordering Basin	Border Length (Miles)
Upper Mississippi	754
Great Lakes	992
Susquehanna	259
Potomac	178
Lower Chesapeake (James)	167
Chowan-Roanoke	116
Pee Dee	129
Edisto-Santee	164
Savannah	121
Apalachicola	37
Alabama	285
Mobile-Tombigbee	274
Lower Mississippi	306
Total ORB Perimeter	3,782

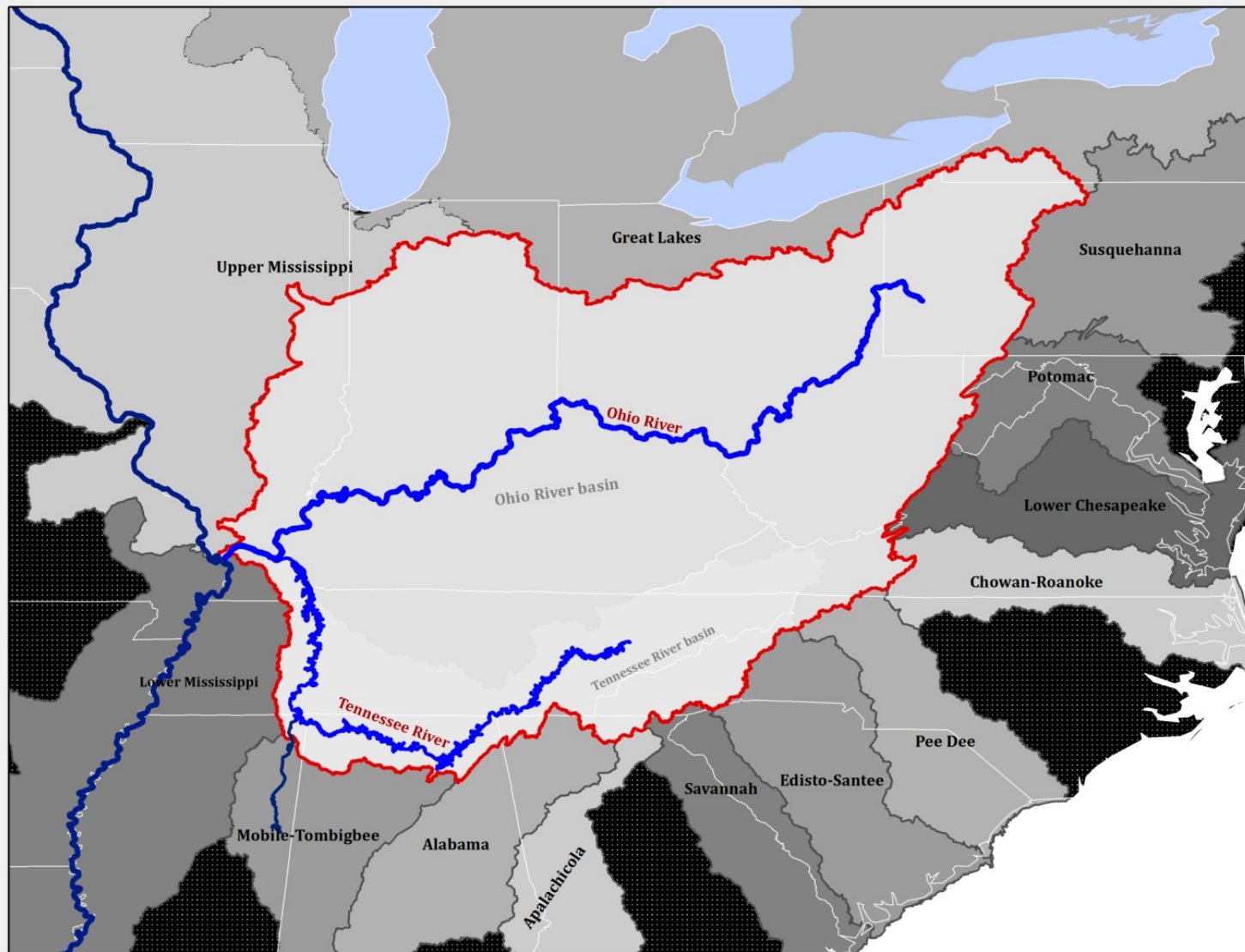


Figure 1. There are 13 major river basins that border the perimeter of the Ohio River basin (inclusive with the Tennessee River basin). Within several of these basins there exist interstate basin commissions that serve as water resource stewards for their respective jurisdictions

Interbasin Transfer Governances

Political vs. Watershed boundaries

Water is considered a natural resource and most state agencies act as stakeholders in the protection of the resources within their state and generate revenue from its uses.

Users/beneficiaries of the resources are often required to make payment for its use therefore it could be in a state's best interests to protect the inflow/outflow of its resources between states. Many states have policies regarding the transfer of water between states however the transfer of water between basins is typically of less interest or value to state agencies. In some cases, this oversight deficiency can be fulfilled by the role of interstate basin commissions or agencies. Interstate basin commissions draw their jurisdictional boundaries independent of political boundaries and rely on the topographical contours that define a watershed. Therefore it may be of most interest to an interstate basin commission/agency to monitor and/or regulate the amount of water transferred in/out of their jurisdiction.

Many of the states within and bordering the Ohio River basin possess their own policies (table 1) regarding IBTs. Implementations of these policies are in the best interests of the state because it protects the sustainable uses of water for downstream users and/or constituents within their political boundaries and aids in maintaining socio-economic stability. Some of those states who have not established their own policies have resolved to adopt the IBT policies outlined by interstate basin commissions. Some of the commissions bordering the ORB implement policies affecting multiple states therefore an introduction to the interstate basin commissions will be provided prior to the outlining the roles of individual states.

Interstate Basin Commissions

To date, there are 7 active interstate basin commissions or agencies bordering the Ohio River basin (not including ORSANCO). These 7 agencies include the: Great Lakes – St. Lawrence River Basin Water Resources Council, Susquehanna River Basin Commission, Interstate Commission on the Potomac River Basin, Apalachicola-Chattahoochee-Flint River Basin Commission, Alabama-Coosa-Tallapoosa, Upper Mississippi River Basin Commission, Savannah River Basin Partnership. The Tennessee River Valley Authority (TVA) is another type interstate agency that is incorporated within the ORB. These commissions have varying levels of involvement in the authorization of interbasin transfers and water withdrawals within their respective jurisdictions. Of the interstate basin commissions bordering the ORB, 4 have interbasin transfer policies. TVA also has an established policy.

Ohio River Valley Water Sanitation Commission (ORSANCO)

ORSANCO is an interstate basin commission representing the majority of the ORB and is the 2nd largest (by drainage area) of these interstate basin commissions, however the Commission is a water quality regulatory agency and does not have an IBT policy. ORSANCO's compact is comprised of 8 signatory states including, Illinois, Indiana, Ohio, New York, Pennsylvania, West Virginia, Virginia, and Kentucky. In regards to the ORB, the regulation, permittance, or reporting of waters transferred in/out of the basin is reliant on an individual state agency, TVA, or a bordering ORB commission.

Great Lakes—St. Lawrence River Basin Sustainable Water Resources Agreement (GL-SLRBSWRA) & Great Lakes – St. Lawrence River Basin Water Resources Council (GL-SLRBWRC)

The GL-SLRBSWRA and GL-SLRBWRC represents the Great Lakes and St. Lawrence River basins (through the ‘Great Lakes Compact’) and includes representations by 8 U.S. states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin) and 2 Canadian provinces (Ontario and Québec). This agreement and commission encompasses the largest jurisdiction by land area and is the most recently established (2005 & 2008 respectively). The legislative creation of this council was to protect the jurisdictional waters in regards to quality and quantity perspectives. This Council does have an IBT policy and refers to them as ‘diversions’ that requires cooperation with all of its member states. The Council prohibits the diversion of water out of the Great Lakes basin with a few exceptions. Those exceptions include the municipal diversion of water in straddling communities (in regards to the basin’s boundaries) and portable containers that are <5.7 gallons. For those diversions in place, rigorous standards have been met for their allowance and operates to achieve ‘no-net loss’ from the Great Lakes basin. To achieve the no-net loss in Ohio, the Ohio-Erie Canal is owned and operated by the State of Ohio and supplies water to the Great Lakes to account for the out-of-the-Great-Lakes municipal diversions and achieve the required no-net loss. The ORB and Great Lakes basin share 992 miles of their perimeters.

“Watersheds cross political boundaries. That’s why we’re here.”

– Interstate Commission on the Potomac River Basin

Susquehanna River Basin Commission (SRBC)

The SRBC represents three states (Maryland, New York, and Pennsylvania) and serves as a permitting authority within its jurisdiction and therefore has an IBT policy. The SRBC requires permits for IBTs out of the SRB if the transfer is >20,000 Gal/day and charges a fee for the use of water. For IBTs entering the SRB, any volume of water must have approval by the SRBC. The SRBC is extensively involved in the regulation of its water resources as a result of the surge in natural gas development within its jurisdiction. The ORB and Susquehanna River basin share 259 miles of their perimeters.

Interstate Commission on the Potomac River Basin (ICPRB)

The ICPRB is an interstate basin commission representing the Potomac River Basin and is comprised of 4 member states (Maryland, Pennsylvania, Virginia, and West Virginia) and the District of Columbia. The ICPRB is not a regulatory or permitting agency and does not have an interbasin transfer policy. The ORB and Potomac River basin share 178 miles of their perimeters.

Apalachicola-Chattahoochee-Flint River Basin Commission (ACF) & Alabama-Coosa-Tallapoosa (ACT)

The ACF and ACT represent the major river basins in each of their names and are comprised of 3 states (Alabama, Georgia, and Florida). These commissions are not a regulatory or permitting authority but are linked through legal matters and negotiated agreements to share water resources within each of their jurisdictional basins. A large reason for the formation of these commissions was to manage and agree upon water allocations between basins (primarily for municipal uses).

Interbasin transfers are agreed upon within and between each commission in accordance with a mutually approved water allocation formula. Interbasin transfers are primarily between each of these commissions rather than between their basins and the Ohio River basin. The ORB and Apalachicola River basin share 37 miles of their perimeters and 285 miles with the Alabama River basin.

Upper Mississippi River Basin Association (UMRBA)

The UMRBA represents the upper Mississippi River basin (upstream of the confluence with the Ohio River) and is comprised of 5 states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin). UMRBA is not a regulatory or permitting authority but serves a forum for discussing and evaluating river resource issues and has addressed issues such as interbasin diversions. Officially, there are no policies regarding interbasin transfers along the 754 miles of shared border between the ORB and the Upper Mississippi basin.

Savannah River Basin Partnership

The Savannah River Basin Partnership is a partnership created by the governors of Georgia and South Carolina to manage the water resources within the Savannah River basin. This bi-state partnership is comprised of a committee that receives support and technical assistance from the Georgia Environmental Protection Division, South Carolina Department of Health and Environmental Control, and South Carolina Department of Natural Resources. The agencies collaborate to promote the sustainable use of water within this basin. This partnership does not serve as a permitting or regulatory authority therefore does not have an interbasin transfer policy. The ORB and Savannah River basin share 121 miles of their perimeters.

Tennessee Valley Authority (TVA)

TVA is a federally- owned corporation created by Congress in 1933 and is a permitting authority for the waters within the Tennessee River basin. TVA does have an IBT policy that requires a permit for water to be withdrawn for any activity that can affect navigation, flood control, or public lands. One unique policy to the TVA is its implementation toward the potential loss of hydropower as a result of an IBT. If an IBT occurs outside of TVA's service area, then the permittee must pay for the loss of hydropower. These policies cover the states of Tennessee, Mississippi, Alabama, Georgia, North Carolina, Virginia, and Kentucky. TVA's jurisdictional boundary comprises the majority of the southern portion of the ORB and is estimated at 1,126 miles in length.

One major IBT that occurs within TVA's jurisdiction is the Tennessee-Tombigbee Waterway which diverts water in the southward direction out of the Tennessee River and into the Tombigbee River which forms a connection to the Gulf Coast via the Alabama River system. This connection enables an alternative route (from the Mississippi River) for the transport of goods, services, recreational opportunities, etc. to the Gulf of Mexico. The average volume of water diverted from the Tennessee River is estimated at 200 Mgal/day.

Table 2. List of interstate basin commissions within bordering and near the Ohio River Basin including the year of enactment, the number of signatory states, the role of a federal representative, and the establishment of an interbasin transfer policy.

Interstate Commission/Authority	Acronym	Enacted	# Signatory States	Federal Representative?	IBT Policy
Ohio River Valley Water Sanitation Commission	ORSANCO	1948	8	Y	None
Susquehanna River Basin Commission	SRBC	1970	3	Y	Permit Req'd
Great Lakes—St. Lawrence River Basin Water Resources Council	GL-SLRBWRC	2008	8		Permit Req'd
Upper Mississippi River Basin Association	UMRBA	1981	5	Y*	None
Interstate Commission on the Potomac River Basin	ICPRB	1940	4†	Y*	None
Apalachicola-Chattahoochee-Flint River Basin Commission	ACF	1997	3	Y*	None
Alabama-Coosa-Tallapoosa	ACT	1997	2		None
Tennessee Valley Authority	TVA	1933			Permit
Savannah River Basin Partnership		2005			None
Chesapeake Bay Commission	CBC	1980	3	Y	
Delaware River Basin Commission	DRBC	1961	4	Y	Permit

*Advisory and non-voting member(s)

† Excludes the District of Columbia

The States' Roles in IBTs

Alabama

The state of Alabama requires an approved registration from Alabama's Office of Water Resources prior to the installation of any permanent off-stream withdrawal of water (temporary installments may be eligible for exemption) capable of withdrawing >0.1 Mgal/day. Any IBT would be subject to this policy. Additionally, in the ORB portion of Alabama any IBTs would be subject to the permitting and regulatory policies established by the TVA.

Georgia

Georgia requires a permit from the Environmental Protection Division for the withdrawal of water >0.1 Mgal/day (monthly average) and mandates specific reporting requirements. Any user intending to transfer water between river basins are subject to the permitting and reporting requirements with the exception of those users transferring water in association with mining, conveying, processing, sale, or shipment of minerals or other products requiring processing or sales. Additionally, in the ORB portion and boundary within Georgia, any IBTs would be subject to the permitting and regulatory policies established by the TVA.

Illinois

Illinois does not have any specific policies or requirements regarding IBTs. However, the Great Lakes basin portion of Illinois is subject to the Great Lakes Compact regarding IBTs. Approval for an IBT would require approval from the Council members in 8 states and 2 Canadian provinces. If permission were granted, rigorous standards would be required such as exploring and exhausting alternatives and the installation of a metering device to monitor withdrawal volumes.

Therefore any IBTs that may occur along the Upper Mississippi-Ohio River basin border are only subject to the state's withdrawal registrations policy and the amount of water transferred is unregulated and undocumented. A permit is required if any withdrawal affects navigation.

Indiana

Indiana has a registration system administered by IN Department of Natural Resources for withdrawal capacities >0.1 Mgal/day and requires the submission of annual report on the water use. The state agency does not have an IBT policy but the northern portion of the state conforms to the policies outlined by the Great Lakes Compact. However, a permit is required if a water withdrawal occurs from a navigable waterway.

Kentucky

Kentucky Department of Environmental Protection is the state's agency that governs water withdrawals and requires permits for withdrawals >0.01 Mgal/day however there are exceptions to this policy. Kentucky does have an IBT policy. Per KYS 151.200, any diversion, on the HUC 6 level, greater than 10,000 gpd requires approval from the cabinet and secretary. Also, the portion of the state that is within TVA's jurisdiction is subject to their IBT policies.

Maryland

A division within the Maryland Department of Environment regulates the withdrawals of waters from within its state and requires a permit for withdrawals of any amount with the existence of some exceptions. The state agency does not have any IBT policy and there are no interference policies available from an interstate basin commission. The waters near the perimeter of the ORB and within the state of Maryland are potentially subject to unregulated IBTs.

Mississippi

The section within the Mississippi Department of Environmental Quality is the state agency responsible for water withdrawal permitting. A permit is required for any water withdrawal volume with the existence of a few exceptions and requires a small permitting fee. The state agency does not have an IBT policy. Waters located in the northeastern Mississippi that are located within TVA's jurisdiction are subject to the TVA's IBT policies. Within this portion of the state lies the Tennessee-Tombigbee waterway which is the largest IBT in the ORB, estimated at 200 Mgal/day.

North Carolina

The North Carolina Division of Water Resources is responsible for water withdrawals and implements a registration system; not a permitting system. Registration of withdrawals are required for using >0.1 Mgal/day and agricultural withdrawals >1.0 Mgal/day and annual water use reports are associated with the registration. Any new IBT installed after 1993 and with the withdrawal capacity >2.0 Mgal/day requires an approved 'certificate' under the Regulation of Surface Water Transfers Act. IBTs across the border of the ORB are subject to the State's policies. Furthermore, those waters within TVA's jurisdiction are subject to TVA's policies.

New York

The New York Department of Environmental Conservation is the permitting authority for water withdrawals. Permits are required for all withdrawals >0.1 Mgal/day and water withdrawn that are >1.0 Mgal/day for agricultural uses require registration. Annual reports on the water-uses are also required for each permit issued. New York does have an IBT policy which defines the transfer of water between 4-digit HUC watersheds and requires registration for transfers of >1.0 Mgal/day (if a permit is not already assigned). New York also complies with the policies set forth by the GL-SLRBC. The ORB located within the state of New York is entirely bordered by the Great Lakes basin and therefore regulated by the GL-SLRBC.

Ohio

The Ohio Department of Natural Resources is the permitting authority within the state and refers to interbasin transfers as 'diversions.' Permits are required for out-of-basin diversions that are >0.1 Mgal/day from the Ohio River basin. Furthermore, the Great Lakes-Ohio River basin borders are subject the IBT policies established by the GL-SLRBC.

Pennsylvania

The Pennsylvania Department of Environmental Protection (PA DEP) is the authority responsible for the registration system within the state. PA DEP does not have an IBT policy. The ORB within the State of Pennsylvania is bordered by three other major river basins which have interstate basin commissions. The Great Lakes and Susquehanna River basins each have IBT policies established

that regulate the transfer of water along their respective basins. However, within the state of Pennsylvania, the relatively short border existing between the Ohio and Potomac basins are subject to potentially unregulated IBTs.

Tennessee

The Tennessee Division of Water Resources (TN DWR) is the permitting authority responsible for the interbasin transfers of public water supplies only. Interbasin transfers are defined by 10 different customized sections (that approximate 6-digit HUCs) of which the boundary of the ORB is comprised within these defined sections. Tennessee also recognizes the transfer of water out of the Tennessee River drainage and into the Cumberland River basin as an IBT. For the purposes of this report, such a transfer is not considered an IBT since it is within the Ohio River basin. Additionally, waters within the State and ORB are subject to TVA's IBT policies, except for the Cumberland River system.

Virginia

Virginia Department of Environmental Quality is the regulatory authority for the state's water resources and possesses an indirect IBT policy. IBTs are categorized under the term 'consumptive use' because the legislative language is written as water that is withdrawn and not returned '...to their source of origin.' Permits are required for consumptive use withdrawals >0.01 Mgal/day. Caveats are associated with these policies and some water-users are exempt. Many IBTs are 'grandfathered' because of their existence prior to the Virginia's Surface Water Withdrawal Program established in 1989 therefore are not subject to the permitting and reporting requirements set forth by the state. There are no interstate basin commissions bordering the ORB with established IBT policies except for the southwestern part of the state that is in the Tennessee River system and subject to TVA's IBT policies.

West Virginia

The state of West Virginia does not have any water withdrawal permitting authority however they do have a registration system that requires large-quantity users (>0.025 Mgal/day) to register and report their annual water-use. The state of WV does not have an IBT policy but water management plans are required to be submitted to WVDEP if the withdrawal is for oil and gas extractions. Within the water management plan, the sources of water withdraws are subject to withdrawal limitations based on the state's withdrawal statutes and maintain pass-by flows. Furthermore, documentation of intra-state IBTs at the 8-digit HUC level was recently initiated in association with these water management plans. The political boundaries of the state also serve as the boundary for a portion of the ORB therefore could be subject to interstate water transfer statutes or MOU's. Additionally, parts of the West Virginia border are within the Appalachia mountain range, which may serve as a physical barrier.

South Carolina

While South Carolina is not in the ORB, we do share a border with South Carolina. 22 miles of South Carolina border the ORB. S.C. does require a permit to transfer water from one basin to another. If 1,000,000 MGD or five percent of the seven-day, ten-year low flow, is withdrawn, a permit is required. S.C. recognizes fifteen rivers or river systems in the state. For the most part they are on the HUC 6 level.

<i>Interstate Basin Commissions</i>	<i>IBT policy</i>
Ohio River Valley Water Sanitation Commission	None
Susquehanna River Basin Commission	Permit
Great Lakes—St. Lawrence River Basin Water Resources Council	Permit
Upper Mississippi River Basin Association	None
Interstate Commission on the Potomac River Basin	None
Apalachicola-Chattahoochee-Flint River Basin Commission	None
Alabama-Coosa-Tallapoosa	None
Tennessee Valley Authority	Permit
Savannah River Basin Partnership	None
Chesapeake Bay Commission	None
<i>ORB States</i>	<i>IBT policy</i>
Alabama	None
Georgia	None
Illinois	None
Indiana	None
Kentucky	Permit
Maryland	None
Mississippi	None
North Carolina	Permit
New York	Registration
Ohio	Permit
Pennsylvania	None
Tennessee	Permit for PWS only
Virginia	Permit
West Virginia	None

Table 3: Interbasin Transfer Policy Summary

Existing IBTs or Diversions

There are numerous IBTs that exist between the ORB and those basins outside its boundaries and they can be classified into one of 4 categories; aquaculture, canals, public water supply, and oil and gas extraction. There is the potential for other IBT categorical withdrawals to exist however the identities of such withdrawals were not documented. The policies established by some authorities (such as TVA) exempt permits/registrations for the withdrawal of waters considered to be for ‘temporary use’. The most likely withdrawal type to exist with such caveats could be classified under agricultural withdrawals for the purposes of irrigation. The withdrawals and potential IBTs from groundwater sources are excluded from table 4 because it can be difficult to identify the true source and receiving surface waters. Therefore the total volumes of water presented within this report are likely to be an underestimate of the ‘true’ IBT volumes existing along the ORB boundary.

Based on the net volumes of the IBTs entering and exiting the ORB, more water is exiting the ORB than entering. Including the canalled diversions, there is a net-loss from the ORB estimated at 228.6 Mgal/day. Excluding the canals, there still remains a net-loss estimation of 22.6 Mgal/day exiting the ORB.

Canal Diversions

Tenn-Tom Waterway

Within the ORB there are 2 canalled diversions that continuously release water out of the basin. The largest is the Tenn-Tom Waterway that diverts an estimated 200 Mgal/day of water from the Tennessee River to the Tombigbee River which then empties into the Gulf of Mexico (Figure 2 and 3). This waterway was constructed and completed by the US Army Corps of Engineers in 1984. It has a design volume of 800 Mgal/day. It is currently operated and maintained via a series of lock and dams. Contracts are in place with municipalities that are permitted to withdrawal water from the Tennessee River and eventually discharge into the Tombigbee River system (see Table 4).

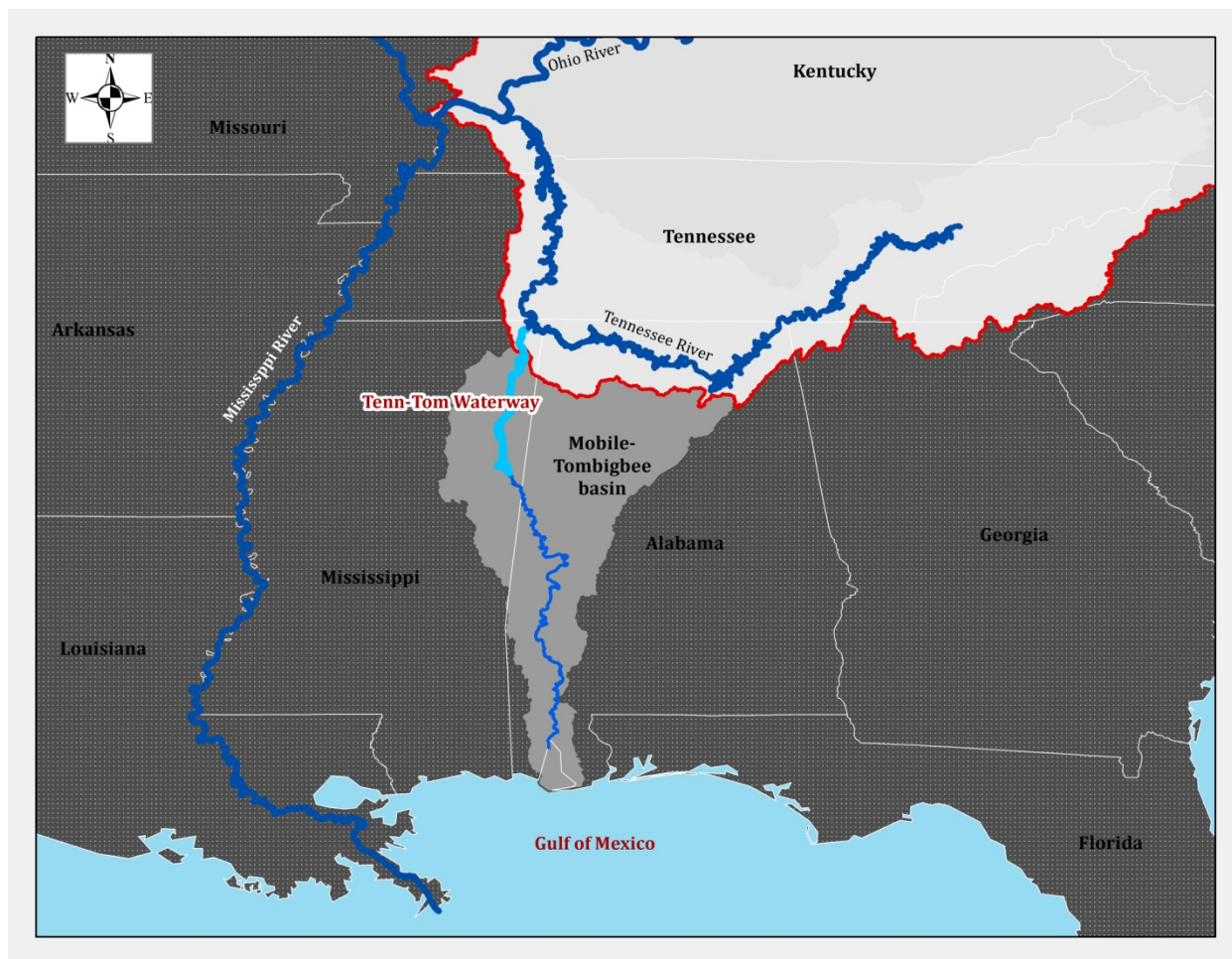


Figure 2. The Tenn-Tom Waterway (Tennessee-Tombigbee) is a man-made canal that connects the Tennessee River to the Tombigbee River and provides alternate navigation to the Gulf of Mexico. This canalled diversion, located near northeastern Mississippi, diverts an average of 200 Mgal/day in a southerly direction from the Tennessee River.

Ohio-Erie Canal and the Portage Lakes System

The other major canal is the Ohio-Erie canal which is located just south of the City of Akron, Ohio and forms a connection between the Ohio River and Great Lakes basins. Specifically, the connection is between the Tuscarawas River (within the Ohio River basin) and the Cuyahoga River (within the Lake Erie basin). Associated with this canal are the series of human-made reservoirs called the Portage lakes which augment the water supply for canal operations (Figure 4). The canal is of significant historical importance because its construction in the early 19th century was a monumental task requiring the laboring from thousands of workers. This canal enabled the efficient and economic transport of products from Cleveland to Portsmouth, Ohio and as well as numerous other cities via the subsequent excavation of ‘feeder’ canals.

Now, the canal is operated by the Ohio Department of Natural Resources and managed to release a minimum of 6 Mgal/day. Current policies require that there is to be no-net loss of water from the Great Lakes basin therefore this diversion serves to balance the amount of municipal water transferred out of the Great Lakes basin and supplied to customers within the ORB.

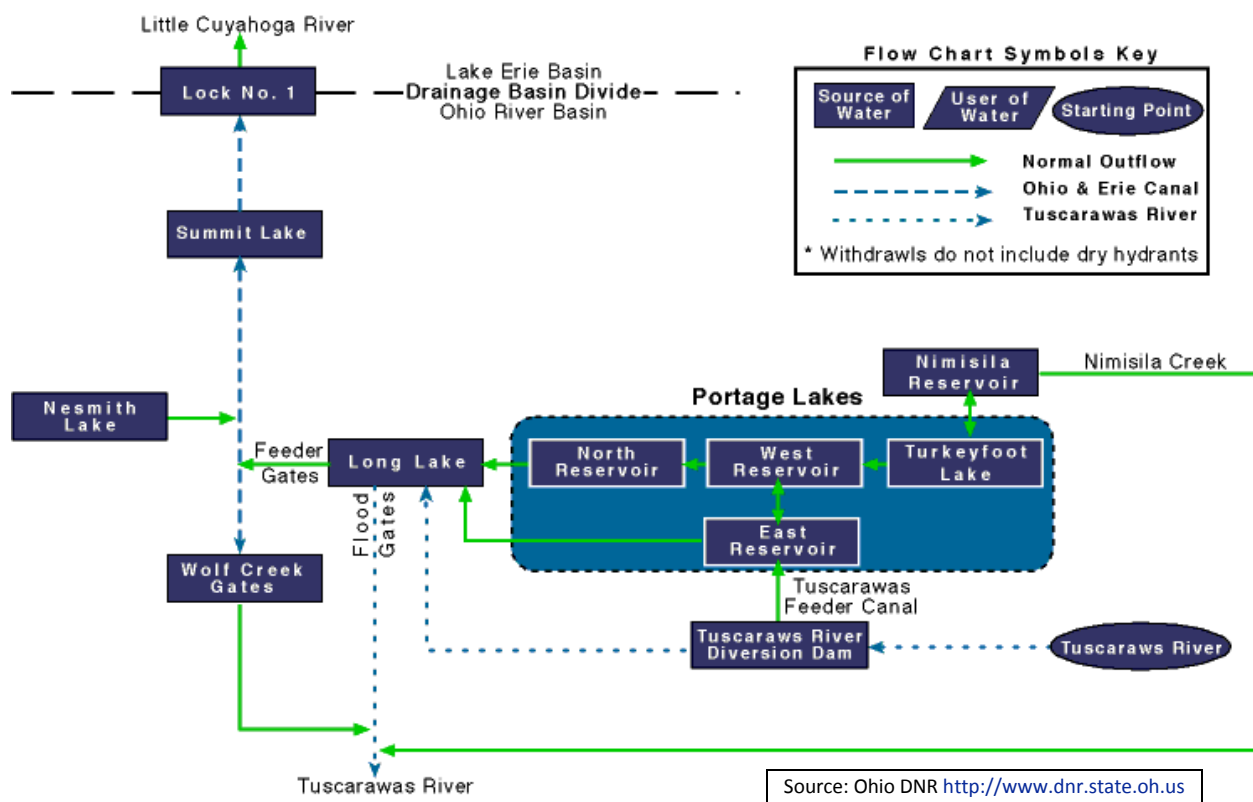


Figure 4. The Ohio-Erie canal is operated in association with the Portage Lakes system and the above schematic demonstrates the mechanisms of water movements between the Great Lakes and Ohio River basins. (Ohio DNR, 2014)

Intermittent Canals

There are two other canals that provide an ephemeral link between the Ohio River and Great Lakes basins. The Miami-Erie Canal is located in northwestern Ohio and connections were made between

the Maumee and Great Miami rivers. The Wabash-Erie Canal formed a connection off the Miami-Erie Canal and linked the Maumee and Wabash Rivers. These canals are no longer in operation and there is no permanent transfer of waters between basins. However, during times of flood, waters may back up enabling the potential exchange of waters. For this reason, these areas are deemed as vulnerable pathways for the spread of aquatic invasive species from one basin to the other.

Municipal interbasin transfers

The only reported IBTs along the boundaries of the ORB are for municipal water supply purposes. There is the potential for the existence of IBTs but their volumes may not be greater than the thresholds established by authorities to require permits or registrations. The sum of undocumented IBTs should be considered *de minimis* in the evaluation of IBTs for the purposes of this report. Most of the documented municipal IBTs occur between boundaries shared by the Great Lakes and Susquehanna River basins as well as the southern ORB border which is regulated by TVA. Table 3 lists all of the known IBTs along the boundaries of the ORB.

Table 4. Numerous interbasin transfers into and out of the Ohio River basin are present along the fringes of the basin boundary and the compilation of a comprehensive list of surface water transfers was attempted. Varying levels of details are provided for each transfer using the most recently available water volumes (most from years >2009). In summary, a net-water loss is experienced in the ORB.

Transfer from			Transfer to			Mgal/day	Regulatory Jurisdiction	Transfer Purpose
System/Description	State	Basin	System/Description	State	Basin			
Exiting Ohio River Basin								
Town of Christiansburg	VA	New River	Shawsville-Elliston Service Area	VA	Roanoke	0.262	None	public water supply
Fort Payne	AL	Tennessee	Fort Payne	AL	Coosa	0	TVA	public water supply
Upper Bear Creek	AL	Tennessee/Bear Creek	Haleyville	AL	Tombigbee	1.58	TVA	public water supply
Albertville	AL	Tennessee	Albertville Service Area & Boaz	AL	Black Warrior	4.51	TVA	public water supply
Arab	AL	Tennessee	Joppa	AL	Black Warrior	0.45	TVA	public water supply
Franklin Co. WSA	AL	Tennessee	Franklin Co. WSA Service Area	AL	Tombigbee	0.4	TVA	public water supply
Hendersonville	NC	Tennessee/French Broad	Saluda	NC	Broad	0.12	TVA	public water supply
Highlands	NC	Tennessee/Little Tennessee	Highlands Service Area	NC	Savannah	0.1	TVA	public water supply
Eastside UD	TN	Tennessee/Hiwassee	Dalton Utilities	GA	Coosa/Conasauga	1.92	TVA	public water supply
Cleveland Utilities	TN	Tennessee/Hiwassee	Ocoee UD	GA	Coosa/Conasauga	0.23	TVA	public water supply
City of Lexington	TN	Tennessee Western Valley	Jackson Energy Authority	TN	Mississippi/Forked Deer	0.1 Est	TVA	public water supply
Tennessee American	TN	Tennessee	Walker County	GA	Coosa	1.8	TVA	public water supply
Corinth	MS	Tennessee	Corinth Service Area	MS	Tombigbee	9**	TVA	public water supply
Lancashire No. 15 20090622	PA	Conemaugh		PA	Upper West Branch Susquehanna	10	SRBC	treatment of mine water
Borough of Ebensburg 20110629	PA	Conemaugh		PA	Upper West Branch Susquehanna	0.249	SRBC	resource extraction
Highland Sewer and Water Authority 20110631	PA	Conemaugh		PA	Raystown	0.249	SRBC	resource extraction
Cambria Somerset Authority 20110630	PA	Conemaugh		PA	Raystown	0.249	SRBC	resource extraction
St. Mary's Area Water Authority 19970701	PA	Clarion		PA	Sinnemahoning	0.3	SRBC	public water supply
Blue Valley AMD Treatment Plant 20100616	PA	Clarion		PA	Sinnemahoning	0.32	SRBC	resource extraction
Frano Freshwater Impoundment 20110913	PA	Middle Allegheny-Redbank		PA	Sinnemahoning	0.482	SRBC	resource extraction
Wayne Gravel Products 20110318	PA	Upper Allegheny		PA	Upper Genesee	1.17	SRBC	resource extraction
Port Allegany Borough 20110633	PA	Upper Allegheny		PA	Sinnemahoning	0.1	SRBC	resource extraction
Scaffold Lick Pond - 1 20110316	PA	Upper Allegheny		PA	Sinnemahoning	0.5	SRBC	resource extraction
Scaffold Lick Pond - 2 20110317	PA	Upper Allegheny		PA	Sinnemahoning	0.5	SRBC	resource extraction
Pennsylvania American - Warren District 20110912	PA	Middle Allegheny_Tionesta		PA		3	SRBC	resource extraction
Johnson Quarry 20110635	PA	Upper Allegheny		PA	Sinnemahoning	0.5	SRBC	resource extraction
Exiting ORB TOTAL						28.991		

Transfer from			Transfer to			Mgal/day	Regulatory Jurisdiction	Transfer Purpose
System/Description	State	Basin	System/Description	State	Basin			
Tenn-Tom Waterway	MS/TN	Tennessee R	Tenn-Tom Waterway	MS/TN	Tombigbee R	200	TVA	Canal Diversion
Ohio-Erie Canal	OH	Tuscarawas R	Ohio-Erie Canal	OH	Cuyahoga	6	GL-SLRBC	Canal Diversion
Canal TOTAL						206		
Entering Ohio River Basin								
Ft. Wayne WW	IN	Lake Erie - Maumee	ORB	IN	Ohio River basin	0.0071#	GL-SLRBC	
Clayton-Rabun Co. W&SA - Lake Rabun	GA	Savannah	Clayton-Rabun Co. W&SA Service Area	GA	Tennessee/Little Tennessee	0.1 Est	TVA	public water supply
Cleveland Utilities	TN	Coosa/Consauga	Cleveland Utilities	TN	Tennessee/Hiwassee	1.09	TVA	public water supply
Ocoee UD		Coosa/Conasauga	Ocoee UD	TN	Tennessee/Hiwassee	0.8	TVA	public water supply
City of Selmer	TN	Mississippi/Little Hatchie	Michie	TN	Tennessee Western Valley	0	TVA	public water supply
DuBois, City of 20060304	PA	West Branch Susquehanna River		PA	Middle Allegheny-Redbank	3	SRBC	public water supply
Berlin Borough Municipal Authority 19980702	PA	Raystown		PA	Conemaugh	0.498	SRBC	public water supply
City of Akron	OH	Cuyahoga	City of Akron	OH	Tuscarawas	0.32	GL-SLRBC	public water supply
Petersburg Fish Hatchery - WVDNR	WV	South Potomac	Petersburg Fish Hatchery - WVDNR	WV	Youghiogheny	0.567	WV DNR	aquaculture
Entering ORB TOTAL						6.3821		
Exiting Total						234.991		
Enter Total						6.3821		
Net Water Gain						-228.6089		

* Anticipated activation in 2012

**Anticipated activation in August 2012

#2009 Calculation

IBTs conveyed to 8-digit HUC sub-basins

A total of 102 HUC-8 sub-basins border the ORB perimeter and consists of 43 within and 59 sub-basins outside the ORB. Each IBT listed (Table 3) was assigned to their appropriate source HUC-8 basin to illustrate the geographic distribution of the known IBTs along the perimeter of the ORB border.

Of the 43 total (HUC-8) sub-basins that share a border and are within the ORB, 16 (or 37%) have at least one IBT exiting the ORB (Figure 5). The number of IBTs that are known to occur in any specific sub-basin ranges from 1 to a maximum of 5 where as the quantity ranges from 0 to 209 Mgal/day. The majority of IBTs exiting the ORB (per sub-basin) are less than 2.0 Mgal/day.

Of those 59 sub-basins sharing a border with the outside of the ORB's boundary, 7 or (12%) have IBTs diverting water into the ORB (Figure 6). The number of IBTs per sub-basin ranges does not exceed two and the volumes range from 0.007 to 3.0 Mgal/day. Only 2 sub-basins divert water volumes greater than 1.0 Mgal/day into the ORB.

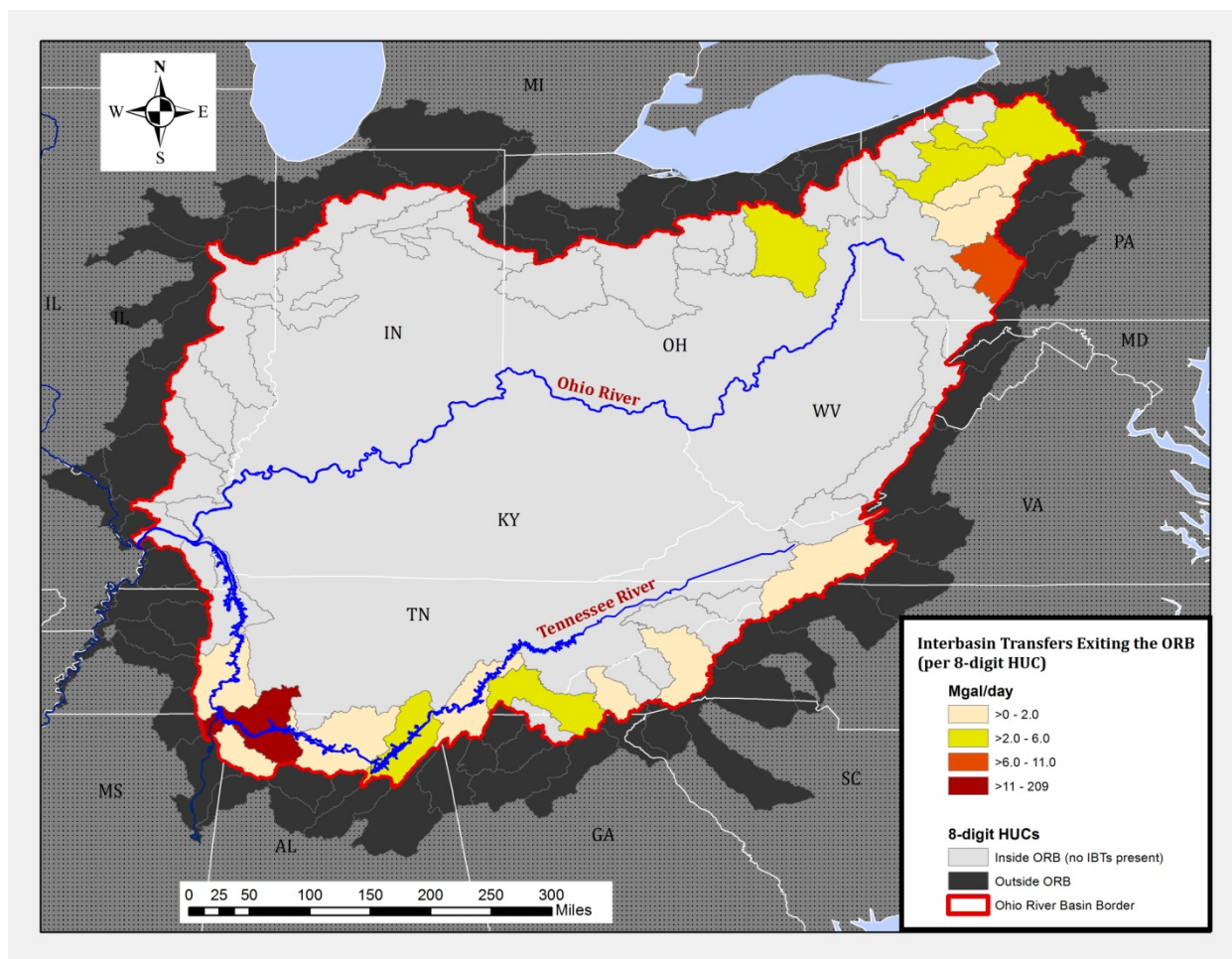


Figure 5. There were sixteen HUC-8 sub-basins identified as having at least one inter-basin transfer exiting the Ohio River basin. In total, the gross volume of water exiting the ORB was estimated at 235 Mgal/day.

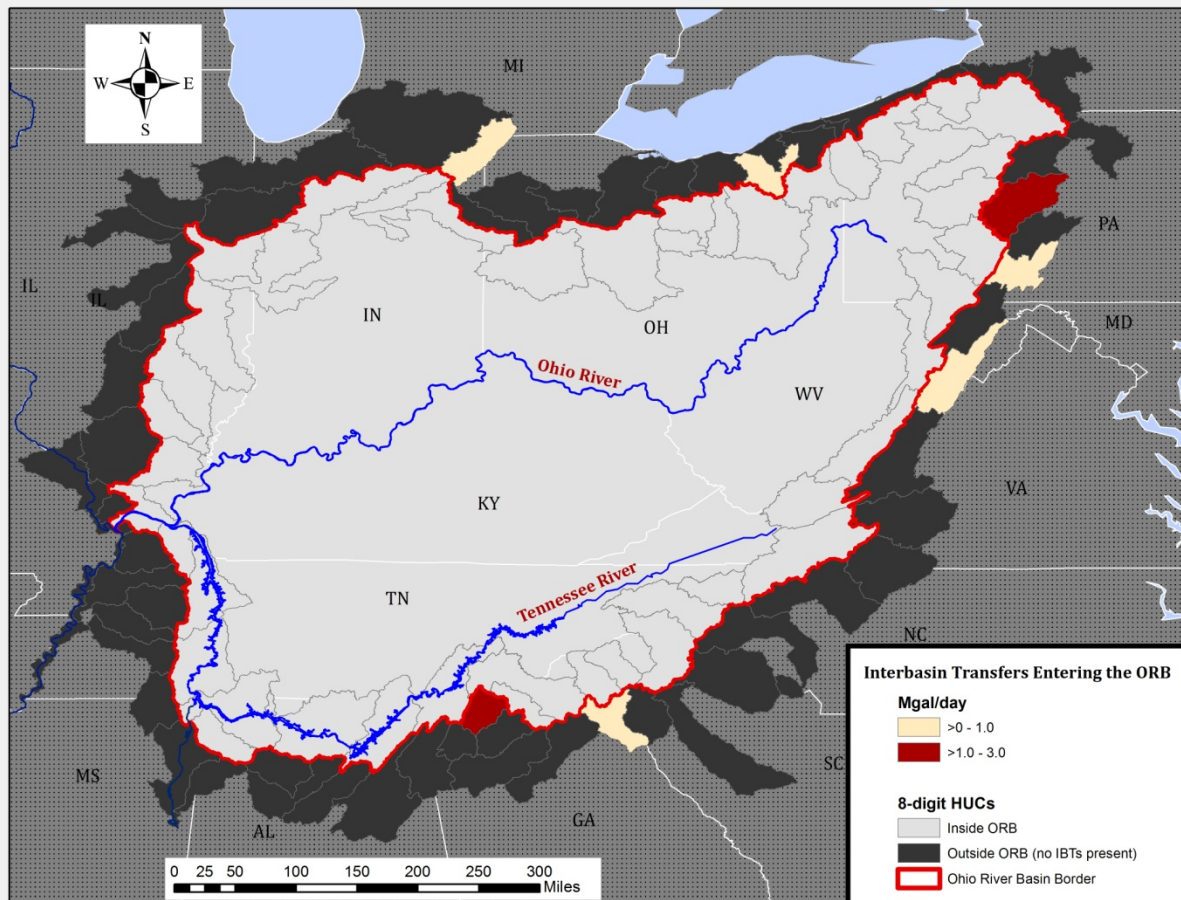


Figure 6. The gross volume of water entering the ORB from IBTs were estimated at 6.4 Mgal/day from which seven HUC-8 sub-basin sources were identified.

IBT Policy Assessment

This section is devoted to identifying the areas on one or both sides of the ORB boundary that have some form of supervision (or lack there of) regarding the exchange of waters between basins. The process of identifying sections of the ORB border with an appropriate protection level involves examining the water withdrawal policies existing on both sides of the ORB boundary and may be determined by policies implemented by an interstate basin commission and/or state agency. Several pre-existing IBTs were established prior to the implementation of water resource policies thereby making these withdrawals exempt from contemporary policies. All of these boundary sections are in regards to new (or modifications to existing) IBTs and ignores those that are 'grandfathered'.

There are 4 different levels of IBT protection including the requirement for water-users to 1) no supervision nor oversight, 2) obtain a permit, 3) registration required, and 4) only public water suppliers need obtain a permit. The locations of these 4 levels are illustrated in Figure 7.

- 1) 1,378 miles of ORB boundary does not require any authoritative oversight regarding IBTs (in red).

- 2) The number of ORB boundary miles where an authority requires a permit is 2,193 miles (in black).
- 3) 211 miles of the ORB, in New York only, requires registration of the withdrawal (permit not required)
- 4) The Public Water supply sections only apply to water entering the ORB.

In summary, 2,193 miles (58%) have some form of supervision/oversight/regulation whereas the remaining 1,589 miles (42%) lack any type of safeguards against unsustainable or unaccounted for water use (Figure 7).

Figure 7 represents the bilateral movement of water along the ORB border. Parallel lines are used to represent the most stringent IBT policy of that section. The outermost line color represents the IBT policy of the state/watershed going into the ORB. While the inner line color represent the IBT policy of the state/watershed/authority leaving the ORB.

One caveat associated with Figure 7 is that the highlighted sections of the ORB boundary is the levels of protection (i.e. permit, registration, none) apply to bilateral movement of water across the boundary. However, there potentially is a 'false protection level'. An example of this is apparent with the ORB-SRB boundary. The figure indicates that this section of the ORB requires a permit for an IBT for the movement of water to and from the SRB. Water can leave the ORB it just can't stay in the SRB basin. A permit is required to transfer water from the ORB if it stays in the SRB. It is important to demarcate that the water resources along the boundary could have potentially disproportional resource-values.

From the perspective of water resources within the ORB, there are exceptions where permits are required for the departure of ORB waters. The State of Ohio, Commonwealth of Virginia, SRBC, and TVA jurisdictions require permits for the transfer of waters across 2-digit HUCs (such as the Ohio and Tennessee River basins). The Commonwealth of VA does not specifically address IBTs but are designated as a consumptive use (thus requiring a permit) because the defined water withdrawal does not return water to its original source waters. The boundaries of these jurisdictional areas exhibit those of least vulnerability for unsustainable water-use.

***'We never know the worth of
water till the well is dry.'***

- Thomas Fuller, *Gnomologia*, 1732

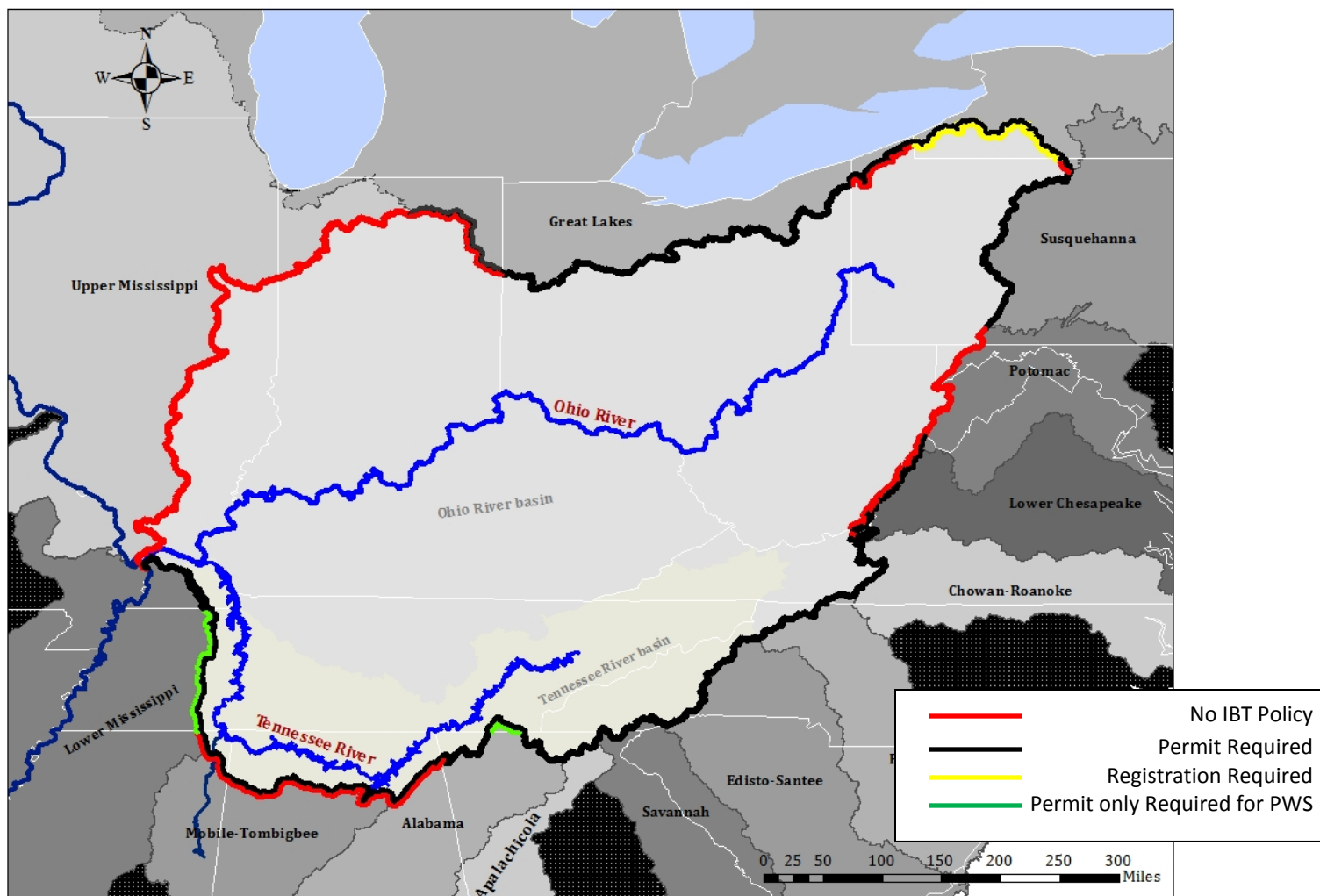


Figure 7. The presence and/or stringency of policies vary along the border of the ORB. This graph shows the stringency of bilateral water movement along the ORB border. The inner line represents the stringency water movement out of the ORB, the outer line represents the stringency of water movement into the ORB. The border of the ORB that requires a permit is shown in Black. Sections in which there is lacking any oversight regarding IBTs are shown in red. Yellow sections only require registration, and green sections lack any IBT oversight except for that of public water supply. For example, in Indiana, along the Great Lakes - ORB border, a permit is required for water to go from the GL to the ORB (black side), but there is no IBT policy for water to go from the ORB to the GL (red side)

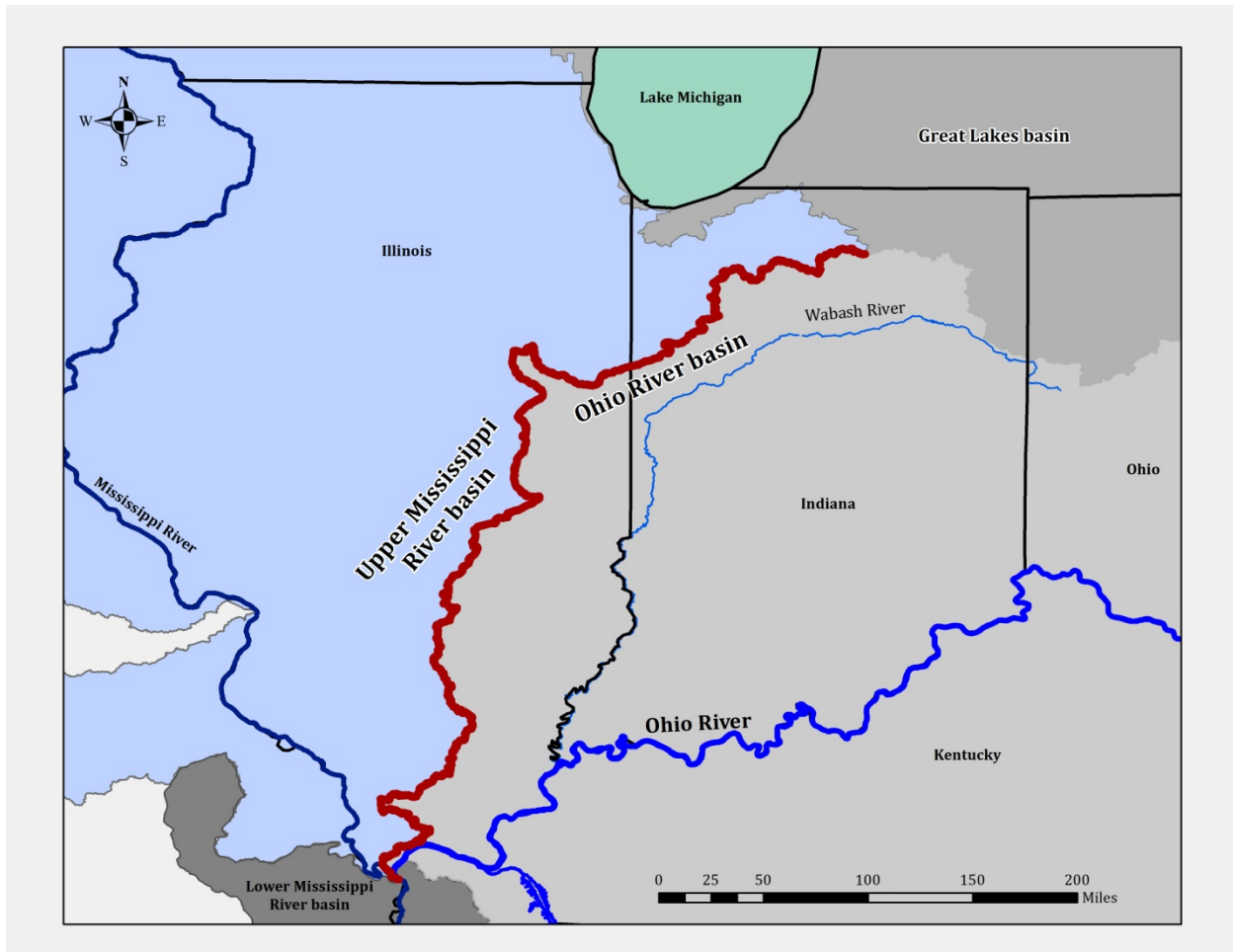


Figure 8. Close-up view of the ORB basin portion in Indiana and Illinois where there exists an IBT vulnerability

The Illinois portion of the ORB, as well as the northwestern portion of Indiana, shares its border with two other basins: Great Lakes and upper Mississippi River basin. There are no specific regulations regarding IBTs between the Mississippi River and the Ohio River basins as well as the lack of documented IBTs. According to conversations with personnel with the respective state agencies, there are no IBTs reported however this does not mean IBTs are non-existent along this boundary.

Other Factors Affecting IBTs

Seasonality

IBTs can have disproportional anthropogenic and ecological effects at differing times of the year. The most adverse effects occur during periods of a declared drought. Water shortages are likely occurring within the declared region but can be compounded in areas downstream. The transfer and subsequent loss of water from numerous locations in the headwaters area can affect the amount of water 1,000 miles downstream, particularly if the downstream region is experiencing drought conditions. For example, 2013 was a relatively wet year. This allows hydraulic drilling companies to take from headwater streams that are experiencing high water levels instead of larger

bodies of water to save on travel distances. The water is then injected into injection wells, sometimes in different watersheds.

Conservancy Districts

Conservancy districts are political subdivisions of the state. They are formed at the initiative of local landowners or political subdivisions to solve water management problems, most frequently flooding. In addition to controlling floods, other potential authorized purposes include: conserving and developing water supply, improving drainage, collecting and disposing of waste, providing for irrigation. Many conservancy districts also provide recreational opportunities in connection with their water management facilities (Ohio DNR, 2014). For example, there are 20 active conservancy districts in Ohio. Each conservancy district operates under the jurisdiction of a conservancy court, consisting of one common pleas judge from each county that is within the district. Pursuant to implementing its court-approved work plan, a conservancy district has the right of eminent domain, and may charge user fees, levy special assessments, and issue bonds. The Muskingum Watershed Conservancy District (MWCD) is the largest in Ohio (HUC 4 level). The MWCD acts independently from other districts. The MWCD has been in the news recently for legally selling water from there district to oil and gas drillers for fracking purposes. The water is then injected into wells, potentially in different basins. This practice of selling water has since ceased until a water availability report is finished, which is being done by MWCD and USGS. The MWCD can sell its water to another HUC 4 watershed and not be subject to the state's IBT policy because it's at the HUC 2 level. More about Conservancy Districts can be found in ORSANCO's "Inventory of Water Resource Laws and Regulations."

Climate Change

Climate change may also affect IBTs. It is estimated by some that more rain will fall in the northern portion of the ORB and less in the southern portion. Also, higher temperatures are expected throughout the ORB, and more extreme events like floods and droughts will occur. As these events happen, better governance will be required to monitor water availability. Higher temperatures, and longer growing seasons may mean more irrigation of crops will be required. If these weather patterns occur at watershed boundaries, IBTs will become more and more common and necessary. Figure 9 shows where the US currently irrigates crops, with some on/near the border of the ORB.

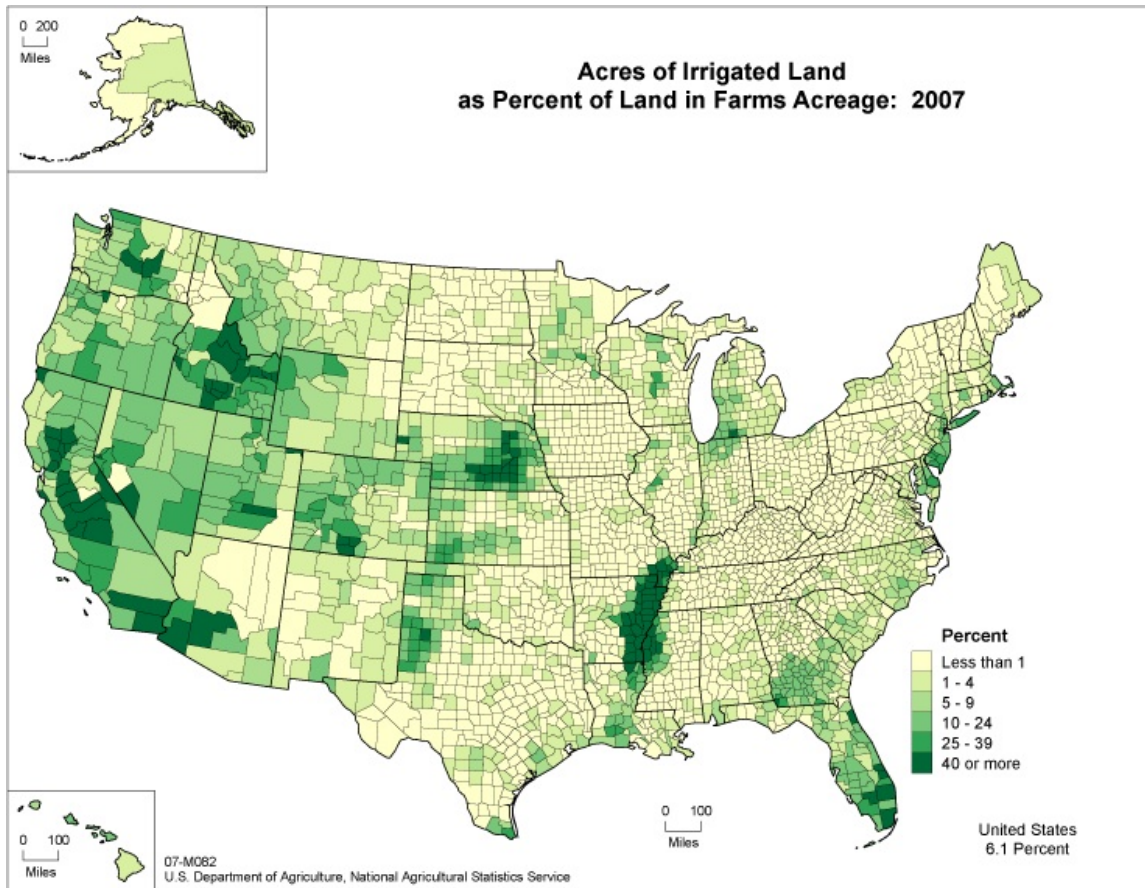


Figure 9. Areas where irrigation of crops is already needed (USDA, 2014)

Discussion

A total of 37 IBTs were identified along the 3,782 peripheral miles of the ORB with an estimated net loss of 229 Mgal/day. The 2 major IBTs are canalled diversions which are responsible for 90% of the water transferred from the basin. The consumptive loss of water from the ORB was estimated at 1,919 Mgal/day (using 2005 data), and in 2012 approximately 5 Mgal/day are consumed from hydrofracking operations therefore the entire water lost from the basin is estimated at 2,153 Mgal/day (Table 5). This is equivalent to 19 TI class supertankers (Figure 10) (which are able to hold approximately 133 Mgal) departing the ORB each day. (As a reference, there are only 4 TI class supertankers that exist in the world!). The Harmonic Mean flow near the confluence with the Mississippi River is 113,000 Mgal/day (175,000 cfs). Thus, 2% of the rivers flow is lost to water consumption. Numerous sources have claimed that the ORB is considered a 'water-rich resource' which is an appropriate term considering that such a large water-loss can be afforded. The acknowledgement of the ORB possessing a 'surplus' of water is stated with numerous limitations and caveats. The continuation of and improvement upon responsible management of water resources in the basin is required to maintain the sustainable uses.

Disregarding the canalled diversions, the basin still experiences an estimated net loss of 22.6 Mgal/day for anthropogenic water-uses. Of the known IBTs, there are 9 that divert water into the ORB whereas approximately 3 times as many exit the basin. Several state and interstate agencies provide some type of oversight regarding the exchange of water across basins. However, the interstate agencies are mostly concerned with water that exits their basin such as the Great Lakes and the SRBC. There are strict requirements and/or policies established for both of these agencies if a user intends to transfer water out of their respective basins. The Great Lakes require an approval process from each of the basin states (and Canadian provinces) where the user must demonstrate alternative water withdrawal options have been exhausted and upon approval, there would be an assortment of requirements and restrictions associated with the transfer. Water exiting the SRB requires the user to acquire approval and a permit (with associated fees for water-use) from the SRBC. Both of these basin commissions allow for the transport of water into their basin without any permitting requirements. This example demonstrates that water is more likely to be exchanged out of the ORB because of fewer restrictions.

IBTs are most probable near the boundaries of a basin primarily due to the decreased distance required for trans-basin movement of water. Excluding the presence of a lake or bountiful groundwater supply, water is likely scarcest at a basin's boundary because most of these streams



Figure 10. 2,148 Mgal of water leave the ORB each day, equivalent to 16 TI class supertankers (each hold ~133 Mgal)

or ditches are likely ephemeral surface waters. Proceeding downstream to perennial streams still experiences a limited natural water supply. Anthropogenic withdrawals from these intermittent and small perennial streams (and even groundwater supplies) can alter the natural hydrograph thereby increasing the vulnerability for recurrent desiccation. These are the areas susceptible to IBTs and the potentially limited water reserves can assert profound socio-economic implications on a community.

Several states do not allow the loss of waters from their basins therefore prohibiting the transfer of waters into the ORB. However, there is no explicit problem with transferring water OUT of the ORB and into another basin. For example, the state of Indiana adopted the GL-SLRBC policy allowing the transfer of water from the ORB and into the Great Lakes but water is prohibited in the reverse

direction. How is it that the Great Lakes is one of the largest bodies of freshwater in the world and the volume in the Ohio River basin is dwarfed in comparison yet based on legislative policies, the water from the Great Lakes is valued as greater than that of the ORB? – a resource which is in greater jeopardy to become limited and subject to the laws of supply & demand.

More information is needed to make a more comprehensive trend analysis of water usage by sectors, hydrofracking operations, water consumption, and IBT's. Hydrofracking water use will more than likely go up but the data is not available yet. Once the 2010 USGS water use data is available more can be said about the trends in water use by sector although past USGS water reports suggest an increasing trend. Some climate change studies also suggest more water will be needed in more southern and western states, potentially increasing the demand for IBT's from the Ohio River basin.

The overall net-loss of water from the ORB indicates it as a source. At present, there is no overarching, common voice within the entire ORB that manages the amount of water entering and leaving. This shortcoming could potentially transpire into vulnerabilities should situations arise where water shortages increase. There may be large urban centers just outside of the ORB that knock on the basin's water-resource-door for public water supply for their citizens, business, and industries.

Table 5. A Comparison of Water Use, Water Consumption, IBT's, and Hydrofracking Water Use

Water-use category	Mgal/day in ORB*	Estimated Consumptive- use (Mgal/day)
Industrial	3,639	364
Mining	324	32
Aquaculture	1,086	0
Domestic Water Supply	359	43
Public Water Supply	3,584	430
Livestock	155	129
Irrigation	217	196
Thermoelectric	34,452	678
Nuclear		47
Total	43,817	1,919
Interbasin Transfer		
Losses		229
Hydrofracking Losses**		12
Total Losses per day		2,160
Ohio River Harmonic Mean Flow		113,000
% of flow lost to Consumptive Use		2

*2005 USGS Water Use Numbers

**2012 Hydrofracking Losses

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