CHESAPEAKE BAY FOUNDATION
Saving a National Treasure

PENNSYLVANIA FACT SHEET

November 2013

Cost Effective Pollution Solutions—Getting the Most Benefit from Our Investments

Chesapeake Bay Pollution

Decades of investments have led to large-scale successes by Pennsylvania in the Chesapeake Bay cleanup effort. We are well on our way to a clean and healthy Bay that acts as a driver for economic activity throughout the 64,000 square mile watershed. These investments are gaining momentum and to distract ourselves now will have numerous impacts to Pennsylvanian's rivers and streams, as well as the Chesapeake Bay.[1,2,3]

Yet, excessive amounts of nitrogen and phosphorous which come from fertilizers, wastewater, septic tank discharges, air pollution, and runoff from farms, cities, and suburbs remain challenges. Disproportionate amounts of sediment are carried into our waterways from erosion coming from construction sites, un-vegetated land, roadside ditches, and even flooded streambanks. Today, along with the Chesapeake Bay nearly 8,000 miles of streams in the Commonwealth are officially designated as impaired due to sediment and/or phosphorus pollution.[4]

Addressing pollution loads utilizing the pollution reduction practices outlined in Pennsylvania's Chesapeake Bay Watershed Implementation Plans and associated Milestones, represent the suite of practices that will restore our local streams and the Bay.[5] Collectively, these practices will not only greatly improve local and regional water quality, they will bring with them tangible ancillary benefits, such as the reduction of flooding events[6], decreased drinking water treatment costs[7], increased recreational activities[8], community revitalization[9], and jobs.[10]

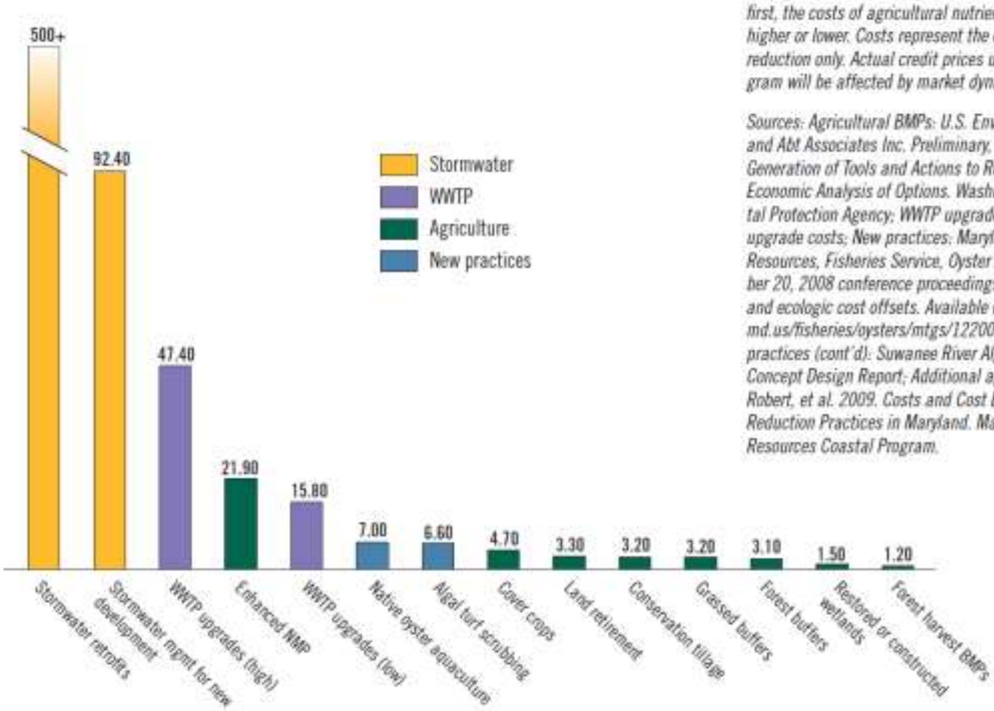
A Pound of Pollutant Reduction—Practices that Produce Results

It's tempting to try to assign a precise dollar value to clean water investments, such as the dollars it costs to remove a pound of pollution, but the reality is that doing so requires a lot of information, is highly site specific, and therefore can be variable.[11] Further confounding such analysis is the fact that what efficiently removes nitrogen, may not remove phosphorus and sediment as cost-effectively. Therefore, each pollutant may have a "more cost-effective" suite of pollution reduction practices.

Determining which type of pollution reduction practice is most appropriate depends on a myriad of factors, including location, site-specific parameters such as soil condition and available area, as well as the regulatory framework within the target area. Similarly, the costs associated with any type of pollution reduction practice can also vary significantly, depending on the amount of treatment and the level of pollution reduction required.

A 2009 report[12] by the World Resources Institute attempted to quantify the average costs of nitrogen removal in dollars per pound for the Chesapeake Bay Watershed. In general, the report found that agricultural **practices which rely on the planting of permanent and temporary vegetation (primarily trees, grasses and shrubs) and land preservation were far less costly to install than practices which required large amounts of capital investment.**

FIGURE 1. Average Cost of Selected Nitrogen Reduction Measures
Dollars per pound of annual nitrogen reduction



Note: Cost estimates do not take into account the baseline or minimum practices that agriculture will have to implement prior to selling credits. Depending on which practices farmers implement first, the costs of agricultural nutrient reduction measures may be higher or lower. Costs represent the costs of achieving the nitrogen reduction only. Actual credit prices under a nutrient trading program will be affected by market dynamics of supply and demand.

Sources: Agricultural BMPs: U.S. Environmental Protection Agency and Abt Associates Inc. Preliminary. 2009. Chesapeake Bay: Next Generation of Tools and Actions to Restore the Bay: Preliminary Economic Analysis of Options. Washington, D.C.: U.S. Environmental Protection Agency; WWTP upgrades: WRI analysis using plant upgrade costs; New practices: Maryland Department of Natural Resources, Fisheries Service, Oyster Advisory Commission. December 20, 2008 conference proceedings: Oyster restoration economic and ecologic cost offsets. Available online at: http://www.dnr.state.md.us/fisheries/oysters/mtgs/122007/meeting122007.html; New practices (cont'd): Suwanee River Algal Turf Scrubbing System Concept Design Report; Additional agricultural BMPs from Wieland, Robert, et al. 2009. Costs and Cost Efficiencies for Some Nutrient Reduction Practices in Maryland. Maryland Department of Natural Resources Coastal Program.

A study published by the Chesapeake Bay Commission[13] in 2004 provides a breakdown of cost-effectiveness for pollutant reduction from six cost-effective pollution reduction practices applicable to either agricultural or wastewater sectors. Designed to be a tool to assist in decision-making, the study identified the most cost-effective pollution reduction practices which could be readily implemented on a large scale to achieve notable reductions in pollutant loadings to the Chesapeake Bay. The table below provides a snapshot of those findings.

	Nitrogen		**Phosphorus**		**Sediment**	
	M lbs.	*$/lb.*	*M lbs.*	*$/lb.*	*M lbs.*	*$/lb.*
Wastewater Treatment Plant Upgrades	35.0	8.56	3.0	74.00	na	
Diet and Feed Adjustments (Ag-Manure)	*data unavailable**		0.2	0.00	na	
Traditional Nutrient Management Plans	13.6	1.66	0.8	28.26	na	
Enhanced Nutrient Management (yield reserve)	23.7	4.41	0.8	95.79	na	
Conservation Tillage	12.0	1.57	2.6	**	1.68	**
Cover Crops	23.3	3.13	0.4	**	0.22	**

**While data related was unavailable in this report, CBF has found that most farms that have implemented diet and feed adjustments reduced feed costs and/or improved production, thus increasing farm profitability.*
***No additional cost incurred for removal of this pollutant by implementation of this practice.*

The USEPA Chesapeake Bay Program has also quantified the costs associated with Pennsylvania's pollution reduction practices that are accepted by USEPA as practices which Pennsylvania assesses towards meeting what would become the Chesapeake Bay Clean Water Blueprint, Watershed Implementation Plans, and Milestones.[14]

Nitrogen

Nonpoint Source Practice	Loading Source	Total Annual Cost	***Pennsylvania*** *Effectiveness* *(lbs load reduced/acre)*	***Pennsylvania*** *Cost-Effectiveness* *($/lb load reduced)*	***Pennsylvania*** *Potential Edge-of-Stream Load Reduction Beyond 2002* *(million lbs reduced/yr)*
Yield Reserve	*(Conventional-Till)*	*$7/Acre*	*13.98*	*$0.50*	*14.71*
Yield Reserve	*(Conservation-Till)*	*$7/Acre*	*15.02*	*$0.47*	*9.13*
Conservation-Tillage	*(Conventional-Till)*	*$2.72/Acre*	*5.78*	*$0.47*	*6.06*
Cover Crops (Early-Planting)	*(Conventional-Till)*	*$27/Acre*	*13.65*	*$1.98*	*14.31*
Cover Crops (Early-Planting)	*(Conservation-Till)*	*$27/Acre*	*11.71*	*$2.31*	*7.12*
Cover Crops (Late-Planting)	*(Conventional-Till)*	*$27/Acre*	*9.04*	*$2.99*	*9.48*
Carbon Sequestration	*(Conventional-Till)*	*$13/Acre*	*13.74*	*$0.95*	*3.64*
Nutrient Management Plans	*(Conservation-Till)*	*$7/Acre*	*10.28*	*$0.68*	*3.10*
Grass Buffers	*(Conventional-Till)*	*$17/Acre*	*27.99*	*$0.61*	*2.47*
20% Poultry Litter Transport	*(Crop Applications)*	*$3.11/Ton*	*9.32*	*$0.33*	*1.72*
Forest Buffers	*(Conventional-Till)*	*$108/Acre*	*49.92*	*$2.16*	*4.37*

Phosphorus

Nonpoint Source Practice	Loading Source	Total Annual Cost	***Pennsylvania*** Effectiveness (lbs load reduced/acre)	***Pennsylvania*** Cost-Effectiveness ($/lb load reduced)	***Pennsylvania*** Potential Edge-of-Stream Load Reduction Beyond 2002 (million lbs reduced/yr)
Conservation-Tillage	(Conventional-Till)	$2.72/Acre	1.06	$2.57	1.12
Animal Waste Management	(Manure Acre = 145 Animal Units)	$8,186/Acre	267.35	$30.62	0.57
Carbon Sequestration	(Conventional-Till)	$13/Acre	0.99	$13.07	0.27
Land Retirement	(Conventional-Till)	$17/Acre	0.65	$25.96	0.18
Forest Buffers	(Conventional-Till)	$108/Acre	2.50	$43.22	0.22
Grass Buffers	(Conventional-Till)	$17/Acre	1.54	$11.06	0.14
Cover Crops (Early-Planting)	(Conventional-Till)	$27/Acre	0.37	$72.32	0.39
Yield Reserve	(Conventional-Till)	$7/Acre	0.17	$40.08	0.19

Sediment

Nonpoint Source Practice	Loading Source	Total Annual Cost	***Pennsylvania*** Effectiveness (tons load reduced/acre)	***Pennsylvania*** Cost-Effectiveness ($/ton load reduced)	***Pennsylvania*** Potential Edge-of-Stream Load Reduction Beyond 2002 (million tons reduced/yr)
Conservation-Tillage	(Conventional-Till)	$2.72/Acre	0.89	$3.07	0.944
Land Retirement	(Conventional-Till)	$17/Acre	1.04	$16.42	0.285
Carbon Sequestration	(Conventional-Till)	$13/Acre	0.93	$13.97	0.248
Grass Buffers	(Conventional-Till)	$17/Acre	1.48	$11.47	0.132
Forest Buffers	(Conventional-Till)	$108/Acre	1.81	$59.55	0.158
Cover Crops (Early-Planting)	(Conventional-Till)	$27/Acre	0.24	$114.02	0.252
Wetland Restoration	(Conventional-Till)	$108/Acre	1.81	$59.55	0.098
Conservation Plans	(Conventional-Till)	$17/Acre	0.30	$57.43	0.084

The Center for Watershed Protection recently completed a study for the James River Association that evaluated the cost-effectiveness of urban pollution reduction practices.[15] This study considered the cost-effectiveness of 39 commonly implemented pollution reduction practices in terms of average annual cost for each practice over 20 years and the annual pollutant reduction in pounds per year. Also intended as a tool for decision-making, the results include practices that are currently approved for credit in the Chesapeake Bay Model by the Chesapeake Bay Program (CBP) as well as practices that are not currently approved by CBP. The authors note that, "**… only those BMPs [pollution reduction practices] approved by CBP may be counted toward progress achieved in attaining water quality goals for and demonstrating compliance with the Chesapeake Bay TMDL."** The table below provides a summary of the three most cost-effective CBP-approved practices by pollutant removed as identified in this report.

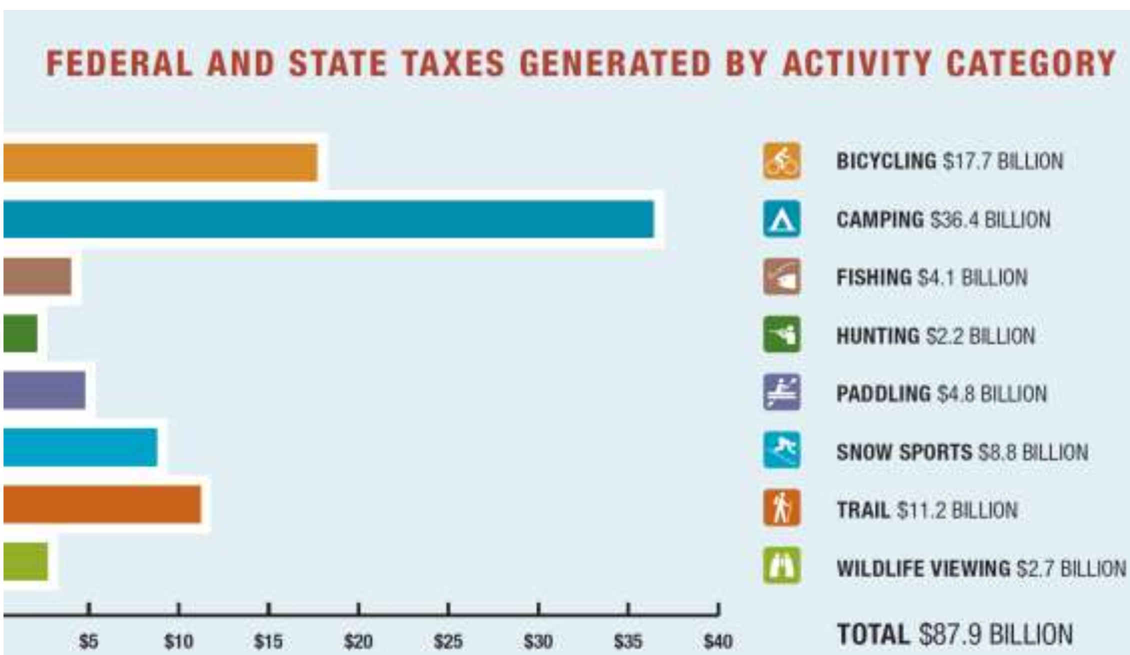
Pollutant	Top 3 of All BMPs	Top 3 of CBP-Approved BMPs
TN	These BMPs cost < $18/lb of nitrogen removed: 1. Pet waste program 2. Illicit discharges- sewer repair 3. Illicit discharges- correction of cross-connections	These BMPs cost < $265/lb of nitrogen removed: 1. Forest buffers 2. Urban growth reduction 3. Urban stream restoration (recommended interim efficiencies)
TP	These BMPs cost < $72/lb of phosphorus removed: 1. Pet waste program 2. Illicit discharges- sewer repair 3. Illicit discharges- correction of cross-connections	These BMPs cost < $1,860/lb of phosphorus removed: 1. Urban Stream Restoration (recommended interim efficiencies) 2. Urban growth reduction 3. Forest buffers
TSS	These BMPs cost < $3/lb of sediment removed: 1. Illicit discharges- sewer repair 2. Urban Stream Restoration (recommended interim efficiencies) 3. Urban growth reduction	These BMPs cost < $4/lb of sediment removed: 1. Urban Stream Restoration (recommended interim efficiencies) 2. Urban growth reduction 3. Vegetated open channels, A/B soils, no underdrain

TN= Total Nitrogen; TP=Total Phosphorus; TSS: Total Suspended Sediment (Sediment)

The costs associated with removing pollution with various practices are an important consideration. However, it's not the only consideration. In fact, the ripple effects—in the environment and in the economy—are equally, if not more important to consider. In that regard, the **pollution reduction practices outlined in Pennsylvania's Chesapeake Bay Watershed Implementation Plans and associated Milestones offer innumerable side benefits.**

An Ounce of Prevention—Protecting Natural Systems

Clean water is vital to all life, but especially important to human life and well-being. Healthy watersheds provide clean water, cleaner air, rich soils, minimization and mitigation of flooding, and provide opportunities for recreation, food and jobs. The best solution for preventing pollution impairments in healthy watersheds is to protect them from degradation, which often results from poor land use decisions and a lack of conservation.[16]



Source: Outdoor Industry Foundation, 2006

Maintaining the health of our waters can help minimize costs associated with flooding. Forests, whether upland or along side streams, reduce the rate at which stormwater runs off the land and allows rainwater to slowly infiltrate, providing substantial groundwater recharge opportunity while reducing erosion on the landscape as well as within stream channels.[4]

Protecting healthy watersheds also helps to promote recreation and tourism. A study completed by the Outdoor Industry Foundation in 2003 found that outdoor recreation generated $88 billion in state and federal tax revenue, provided approximately 6.5 million jobs, and contributed $730 billion annually to the national economy.[4]

Economic and Environmental Benefits Go Hand In Hand

When considering the economic benefits of conservation practices, **it is important to also consider ancillary benefits to the environment, health and human welfare, and indirect financial benefits to farmers that result from their implementation.** These bonus benefits include carbon sequestration[17], improved wildlife habitat[18, 20], increased groundwater recharge[18], reduced flooding[19], and improved water quality[20, 21], among others.

Employing sound conservation practices is not only good for the environment; but in most cases, it strengthens a farmer's economic bottom line. Some examples include:

- **Conservation practices** such as no-till cultivation and cover crops improve soil quality, enhance soil organic matter and structure, prevent the loss of valuable topsoil and nutrients, and improve water infiltration to minimize impacts of both drought and flooding. Crop yields improve, and long-term productivity of the soil is conserved.

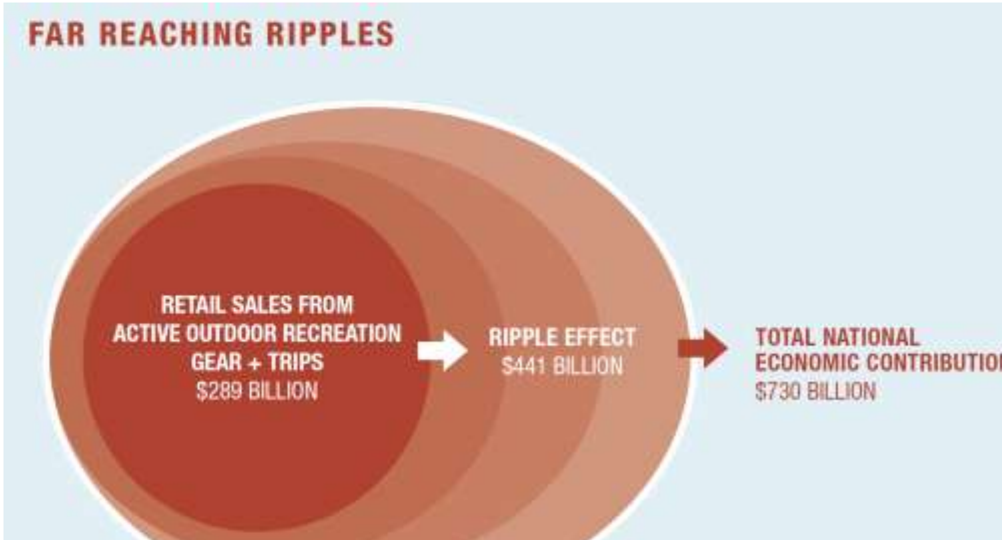
- **Improved manure storage facilities** enhance nutrient retention and utilization for crops, thus reducing fertilizer costs. Increased storage capacity minimizes the need for manure applications during winter, a time when risk of nutrient loss and pollution is high.

- **Rotational grazing** allows livestock to have access to high quality forages, reduces feed costs, cuts the labor needed for livestock feeding, and improves animal health, while reducing soil erosion and improving manure nutrient utilization by vegetation.

- **Precision Feeding** improves feed efficiency by matching nutrients in feed to cow production requirements, so that more nutrients are used for milk production with less waste. This can both reduce feed costs and improve milk production in many herds, while reducing the nitrogen and phosphorus content of manure.[22,23]

- **Keeping cattle out of streams** will reduce their risk of injury on steep, slippery banks, as well as exposure to mastitis, leptospirosis and other diseases from upstream herds. Cattle in muddy, manure-laden barnyards are also prone to disease and injury, so improvements to divert stormwater and facilitate manure removal from the barnyard will improve herd health.[24]

- **Streamside forests** provide a wide range of benefits, including reducing the potential for downstream flooding and capturing nutrients and sediment before they enter the water. Researchers at the Stroud Water Research Center found that forested streams were able to process significantly more nitrogen than contiguous sections of streams devoid of forest buffers, with most showing a two- to eight-fold increase.[25] Trout and other wildlife rely on forested streams, because the falling leaves feed the microorganisms and insects that in turn feed the fish. Trees provide wildlife habitat, and cool the stream so that it is more hospitable to fish.



Source: Outdoor Industry Foundation, 2006

The environmental and economic benefits of conservation practices are not limited to agricultural settings. Urban and suburban conservation practices also provide a number of bonus benefits, including:

- **Clean water decreases public health costs** associated with consumption of contaminated fish and exposure to waterborne pathogens during recreation.[26]

- **Lower capital improvement costs** through conservation-based development.
    - A study completed by the National Resources Defense Council found that pollution prevention is not only effective, but saves money over the long term.[27]
    - Another study completed by the National Resources EconNorthwest found Low Impact Development practices typically cost less to install, incur lower operation and maintenance costs, and provide more cost-effective management of stormwater than conventionally designed sites.[28]
    - EPA compiled seventeen case studies that showed reduced project costs and improved environmental performance with Low Impact Development practices. These projects returned savings of 15-80% in the overall associated capital costs.[29]
    - Existing urban trees intercept rainfall and promote infiltration to aid in the management of stormwater. American Forests reported the preservation of existing trees avoided one-time construction costs attributed to stormwater in the Chesapeake Bay region as $1.08 billion.[30]
    - Several studies have demonstrated that low impact development and conservation design, including well-designed surface stormwater management features like constructed ponds and wetlands, can increase property values. [31,32,33] Philadelphia estimated that that installation of green stormwater infrastructure throughout the city would raise property values from two to five percent over the 40 years, generating $390-million in increased home values near green spaces.[34]

Finally, according to the Pennsylvania Fish and Boat Commission, nearly two million people go fishing in Pennsylvania each year, contributing over $1.6-billion to the Commonwealth's economy. An additional $1.4-billion is spent in Pennsylvania on trip-related expenses and equipment exclusively for wildlife watching. Pennsylvania's own residents spend approximately $1.7-billion on boating annually.[35] Clean water will ensure these sources continue to provide annual revenue to support Pennsylvania's economy.

Getting the Most Bang for the Buck

As detailed above, the cost for pollution reduction practices to remove a pound of pollutant various greatly by sector, type, and pollutant treated. **But it's important to note that for many of these practices a large number of ancillary environmental and economic benefits that directly impact the Pennsylvanian's quality of life and economic vitality.**

While significant progress has been made in all sectors, there is still a great deal of improvement needed across all sectors to protect, preserve, restore and maintain water quality in the Chesapeake Bay and its tributary rivers and streams. **Investing available funds wisely in proven solutions that do not require large upfront costs and/or high risk remains the most prudent use of taxpayer money.** That is why CBF has and will continue to support efforts in the agricultural and urban/suburban areas to improve water quality and fight for cost-effective solutions to pollution through conservation that counts.

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CHESAPEAKE BAY FOUNDATION
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Founded in 1967, the Chesapeake Bay Foundation is a nonprofit 501(c)(3) conservation organization dedicated to saving a national treasure—the Chesapeake Bay and its rivers and streams. Its motto, Save the Bay, defines the organization's mission and commitment. With headquarters in Annapolis, MD, offices in Maryland, Virginia, Pennsylvania, and the District of Columbia, and 17 field centers, CBF works throughout the Chesapeake Bay's 64,000-square-mile watershed to build an informed citizenry, advocate pollution-reduction strategy, and enforce the law. CBF is supported by more than 200,000 active members and has a staff of 170 full-time employees. Approximately 80 percent of CBF's $23.6 million annual budget is privately raised.