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For Drought Information

Visit the

Delaware Water Resources Center (DWRC) site:

<http://ag.udel.edu/dwrc/news.html>

Our link is to the *Delaware River Basin Commission (DRBC)* drought web site maintained by the State of New Jersey at <http://www.state.nj.us/drbc/>. Click "Drought Information" to find Delaware-related links:

- *DNREC* drought information at www.dnrec.state.de.us/DNREC2000/drought.asp
- *DRBC* recent press releases describing the progression of drought declarations and current drought actions for the region
- US and Delaware Geological Surveys (*USGS* / *DGS*) measured stream flows and ground water levels [see the *USGS* District web page at <http://md.water.usgs.gov> for real-time data]
- National Weather Service weather forecasts
- ... and more, including a kids' drought page.

SPRING 2002

A Historic Drought for Delaware Delaware Water Supply Coordinating Council Seeks Cooperative Water Supply Solutions

The following three articles were contributed by Gerald J. Kauffman PE, State Water Coordinator at the University of Delaware, College of Human Services, Education and Public Policy, Institute for Public Administration, Water Resources Agency.
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Delaware and surrounding Mid-Atlantic watersheds have just experienced a rare winter drought of historic proportions. The second half of 2001 was the driest ever at Wilmington Airport, according to rain gage records kept since 1895. The record-breaking warm winter added to the dryness by increasing evaporation from streams and soil layers. During February 2002, daily stream flows along Wilmington's Brandywine Creek were the lowest on record dating to World War II. Experiencing drought conditions so early in the year, when residents have not yet begun watering lawns or washing cars, is cause for special concern because the recent droughts of 1995 and 1999 deepened only during the late summer months.

Ensuring reliable delivery of drinking water to Delaware residents is complicated by the fact that political jurisdictions and water supply franchise areas do not coincide with topographical and aquifer drainage divides. Delaware shares its aquifers and streams with the watersheds of the Delaware River and Chesapeake Bay basins found in Maryland, New Jersey, New York and Pennsylvania, and additionally among over 20 water purveyors ranging from the municipally-owned Cities of Wilmington, Dover, and Lewes, to the investor-owned Artesian Water Company, Tidewater Utilities, and United Water Delaware. Water scarcity, therefore, has the potential to create water supply conflicts between different political jurisdictions and between public and private water purveyors.

A number of actions have been taken to foster cooperation among states and (**continued page 2**)

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(Historic Drought, continued from page 1)

State Water Coordinator Gerald Kauffman



between municipal and private water purveyors. *The Delaware River Basin Commission (DRBC)* and Christina Basin Drought Management Committee are two examples of watershed-based governance organizations that work to ensure that water is shared equitably within each state and across state lines. The *DRBC*, the nation's first agency to partner the federal government with states for purposes of river basin planning and development, currently regulates water pollution abatement, water supply allocation, use permits, water conservation initiatives, regional planning, drought management, flood control and recreation in the four-state Delaware River Basin. When the *DRBC* declared a drought emergency in late 2001, the four surrounding states issued drought assessments ranging from emergency, to warning, to no advisory at all, despite the shared watershed system. However, by March 12, when Delaware Governor Minner declared a statewide drought warning requesting citizen voluntary water conservation, more cooperative efforts by organizations such as the *DRBC* had resulted in more uniformity among state drought declarations, and there was a clear understanding that water supply would be a serious regional problem in 2002.

In Delaware, the Governor and State Legislature recognized the complexity of developing a long-term approach to manage the state's water supply and unanimously passed a law after the drought of 1999 appointing a "State Water Coordinator" and *Delaware Water Supply Coordinating Council (WSCC)*. The *WSCC* serves as a governance structure to work with public and private water utilities to overcome the conflicts that rise during times of water scarcity, and to build 1 billion gallons in reserve storage in northern New Castle County by the end of 2003. The *WSCC's* goal is to build the successful cooperation across political and water franchise boundaries that is needed to provide safe and plentiful drinking water to Delaware residents and businesses, even during times of record drought.

Meeting the Demands of Drought: Storing Water Reserves



Proposed Newark Reservoir (317 mg)

Delaware's largest and only reserve water storage facility is the City of Wilmington's Colonel E. M. Hoopes Memorial Reservoir which holds 1.8 billion gallons of useable water, equal to about 2 to 3 months of reserve water storage. Hoopes Reservoir was constructed in 1932 for \$3 million (\$ 33 M in 2002 dollars). The reservoir work cleared 480 acres of land, making this one of the largest public works projects in Delaware history.

The water purveyors on the *Delaware Water Supply Coordinating Council* have made many improvements since the droughts of 1995 and 1999. United Water Delaware installed the inflatable Tidal Capture Structure along the White Clay Creek at Stanton, which stored 700 million gallons during the drought of 1999. Artesian Water Company drilled several new wells north of the Canal.

Today, five projects receive *WSCC's* greatest priority. Construction is targeted by the City of Newark for early 2003 for the new 317 mg Newark Reservoir off Paper Mill Road and also the 60 mg South Well Field Iron Removal Plant on Rt. 72 near I-95. The City of Wilmington has made available 500 mg of water from the top wedge of Hoopes Reservoir for surrounding water purveyors who elect to pay for a stake in the water. Artesian Water Company has pumped 100 mg of water into new Aquifer Storage and Recovery wells and is drilling new wells which will provide 120 mg during a 60-day drought. When these priority projects are built by 2003, northern New Castle County should be 99% reliable against drought through 2020.

Back-up water supply projects are also under consideration and include the proposed Bread and Cheese Island Reservoir, a pipeline under the C&D Canal, a Philadelphia to Delaware Pipeline, a Desalination facility, and the Thompson Station Reservoir. However, many economic, environmental, and institutional constraints must be overcome to make any of these projects a reality.

WSCC Water Conservation Tips

Find the latest semi-annual reports issued by the Water Supply Coordinating Council on the Water Resource Agency web site: <http://www.wr.udel.edu>

In northern New Castle County the normal regional water demand is 60 million gallons / day (mgd), while peak summer demand is 90 mgd – a 50% increase due almost entirely to outdoor water use. Each resident uses about 100 – 150 gallons per day, yet only 8 gallons are actually needed for human sustenance. Many opportunities for water conservation are available today that could help during times of drought, such as:

- Take shorter showers and save 25 – 50 gallons of water.
- Use a dishwasher (2 gallons) instead of handwashing dishes which takes 20 gallons of water.
- Wash your car on the lawn or gravel instead of the pavement to let the water sink into the ground.
- Use drought-tolerant plants for home landscaping and in the garden (contact the *Master Gardeners Program* of the UD College of Agriculture and Natural Resources 302 – 831 – 8862 for recommendations.)
- Save over 300 gallons by watering the lawn in the morning instead of during the heat of the day. Or save over 600 gallons over a few hours by not watering your lawn at all, and let the lawn go dormant during summer droughts – it will recover when the rains return.
- A rediscovered water conservation technique is the use of an old farming technique – rain barrels. During April, the UD *Institute for Public Administration* began distributing rain barrels to the public through a program funded by the USEPA and DNREC. Each barrel stores 55 gallons of water which can be used to sprinkle the garden and save tap water.

JOBS in WATER RESOURCES

Visit <http://ag.udel.edu/dwrc/jobs.html> which features **DWRC** and other agency internships, fellowships, career planning and employment links. **New from the USGS Delaware Subdistrict:** student opportunities for summer 2002. Field helpers are needed to work from Dover. Call Dan Soeder at 302-724-2506 x238 (dsoeder@usgs.gov) or Judy Denver at 302-724-2506 x229 (jmdenver@usgs.gov) for more information.

Improving Delaware's Water Quality One Back Yard At A Time

Jen Gochenaur, Stewardship Coordinator
Delaware Nature Society

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The *Delaware Nature Society (DNS)* in partnership with the *National Wildlife Federation* has launched a new "Backyard Wildlife Habitat Program" aimed at educating citizens, youth, and private sector landowners about their impact on the health of waterways and at encouraging stewardship of Delaware's water resources.

Why focus on backyard habitat? In Delaware, one of the biggest threats to clean, safe water for drinking, swimming, or supporting standards for fish and aquatic life, is nonpoint source pollution – that is, pollution from many diffuse sources such as yards, farms, roadways and construction sites. Currently, 87% of Delaware land is privately owned, which means private landowners need to understand that contaminants from their property such as sediments, septic tank effluent, pet waste, fertilizers, and pesticides can be carried into local streams via storm runoff or ground seepage. By creating backyard habitats using native plants that require less water and fertilization, limiting the use of lawn chemicals, and reducing storm water runoff, owners can help decrease nonpoint source pollution and ensure cleaner water. Owners of streamside homes who mow



directly to the stream banks may find the practice causes the banks to become unstable, ultimately creating severe erosion problems impacting stream health while washing away valuable property. Creating a backyard habitat that includes a vegetation buffer along streams will stabilize banks, provide excellent habitat for wildlife, and cool adjacent waters – all of which can improve water quality. These efforts support "Delaware's Biodiversity Initiative", DNREC's total maximum daily loads standards for managed water quality, and Governor Minner's "Livable Delaware" initiative.

Free technical assistance is available from DNS "Habitat Stewards" who provide yard evaluation and also certify property owners that establish habitats for wildlife while implementing water quality conservation practices.

Residential Water in Northern New Castle County: Scarcity Pricing for Conservation

Dr. Joshua Duke and Robert Ehemann
UD Department of Food and Resource Economics

During the drought of the summer of 1999, no price increase for residential water was implemented to encourage conservation. Residents were instead fined if they violated drought-imposed restrictions.

In the following year, Robert Ehemann, then a **DWRC** undergraduate intern working with advisor Dr. Joshua Duke, Assistant Professor in the UD College of Agriculture and Natural Resources Department of Food and Resource Economics, conducted research to determine whether increasing the cost of water is an efficient and fair method for allocating water in times of scarcity. The team, which at the time coordinated efforts with the UD *Water Resources Agency*, additionally evaluated whether conservation measures, including those which result from the increased cost of water, will eliminate the need to expand water supplies.

Duke and Ehemann, who is now a Delaware state parks planner working for *DNREC*, have completed a third publication either directly sponsored or encouraged by the **DWRC**. They conclude that effective water management requires pricing for conservation purposes be used in combination with other efforts targeting reduced usage. Consumers understand scarcity pricing for other goods such as specialty foods or gasoline, and thus will choose to pay a premium for less essential outdoor use, or to conserve and pay a lower bill. The team reports that “the current system, in contrast, offers confusing signals when droughts occur but price remains fixed. Simultaneously, consumers have an incentive to over-consume water—because its cost is below the market value of the resource—while governments are calling for conservation. Governments may request voluntary reductions or, in severe droughts, mandatory restrictions on outdoor use. After a drought, consumers may face higher prices—though water is plentiful—so suppliers can recover from losses incurred during the drought. When scarcity pricing is not used, consumption is encouraged when it should be discouraged, and discouraged when it should not.”

Duke and Ehemann propose a “usage threshold” that would protect the water consumers use for basic needs from price increases and conservation requirements. Consumption under the threshold is charged a low, fixed price; above the threshold, the

unit price of water can increase to encourage drought conservation practices. The political process used to set “usage thresholds” is able to accommodate households with many occupants or extraordinary outdoor watering demands.



Photo by Jonathan Cox

The report concludes by exploring how the most efficient water price varies with changing water demand deficits, thresholds, and consumer responsiveness. The result is improved information about scarcity water pricing that will most effectively signal the need for consumer conservation in times of drought. For more information on this report, contact Dr. Joshua Duke (302-831-1309, duke@udel.edu).

U. of D. College of Marine Studies News: Menhaden Murder Mystery Solved

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Visit us on the Web at <http://www.ocean.udel.edu>

Oceanography professor and expert in marine chemistry George Luther is working with colleagues at *DNREC* to correct a chemical imbalance that killed more than 2 million menhaden bait fish in the Rehoboth Bay in the summer of 2000. Luther and his research team had developed a sensor to test his theory that the deaths were caused by high concentrations of dissolved hydrogen sulfide brought to the surface during storms from deep holes in the Bald Eagle Creek and manmade Torquay Canal system. Some holes, created when developers used sand and mud from the bottom to build up soil for local housing developments in the 1960's, were as deep as 18 feet and as large as a football field. They affect water flow, causing stagnation and allowing for the accumulation of dying algal blooms that had been caused by excess nutrients from fertilizers, sewage treatment and other sources. Bacterial decomposition of the decaying algae and other organic materials creates the highly toxic hydrogen sulfide. Filling in the holes to restore the overall depth to Rehoboth Bay's average of 6 feet may solve the problem.

The Role of Land Use and Land Cover in the Delivery of Nutrients to Delaware's Inland Bays

**Jennifer Jennings, DWRC 2000 – 2003 Fellow
Dr. William Ullman and Mr. Joseph Scudlark,
Advisors, College of Marine Studies
University of Delaware**

Photos by Jonathan Cox

Two years into her **DWRC** graduate fellowship project spanning 2000 – 2003, Jenn Jennings remains enthusiastic about future applications and development of her research. "As a native Delawarean, I was attracted to the idea of working on a project that would one day lead to an improvement in our waters and ecosystems," Jennings says. "I was further interested in the idea of exploring how, or if, changes in the land use brought about by human encroachment in [the] coastal area [of Delaware's Inland Bays] were affecting the nutrient levels there, and if this rising trend could be reversed by improved land management practices."



The fellowship project, one of three currently funded by the **DWRC**, will determine baseflow and storm nutrient loads, their seasonal variability, and the role of surrounding land use and land cover in the attenuation and delivery of nutrients to the estuary. The research builds on efforts conducted by the University of Delaware's College of Marine Studies, Delaware Department of Natural Resources and Environmental Control (**DNREC**) and the U.S. Environmental Protection Agency (**USEPA**) Coastal Intensive Site Network (**CISNet**) program.

Jennings was no stranger to water monitoring when she applied to the new **DWRC** fellowship program. She explains, "As a UD undergraduate in Chemistry, I conducted research with Dr. Tom Church on the environmental fate of arsenic and other metals. Part of that research effort, collecting and analyzing water samples from the White and Red Clay Creeks in New Castle County, expanded to include sampling of the Inland Bays and their tributaries. I then met Dr. Bill Ullman who explained to me his analyses of the Bays' water for another purpose – evaluating the effects of nutrient over-enrichment on declining water quality."

Nutrient over-enrichment, or "eutrophication", is caused by elevated nutrient loadings from domestic,

municipal, industrial, and agricultural practices in the Inland Bays' surrounding watersheds. The phenomenon has led to excess nitrogen and phosphorus fertilization of estuarine plants, changes in phytoplankton species, and noxious and toxic algal blooms. Other effects of eutrophication on the ecosystem include increases in turbidity and decreases in dissolved oxygen concentrations, both causing reductions in biodiversity, habitat, and fish and shellfish viability.

In the coming year, Jennings (below, at the Inland Bays' Bundicks Branch sub-watershed monitoring site) will calculate actual loads for her sampling periods, analyze a large existing database to derive loads for past years, and finally develop a model for estimating total annual storm loads. "The main objective of my research," she states, "is to use these actual water measurements to calculate the total nitrogen load to the Inland Bays and compare my results to levels estimated by Horsley & Witten, Inc., an environmental consulting firm, in a 1998 report prepared for the *Center for the Inland Bays*."



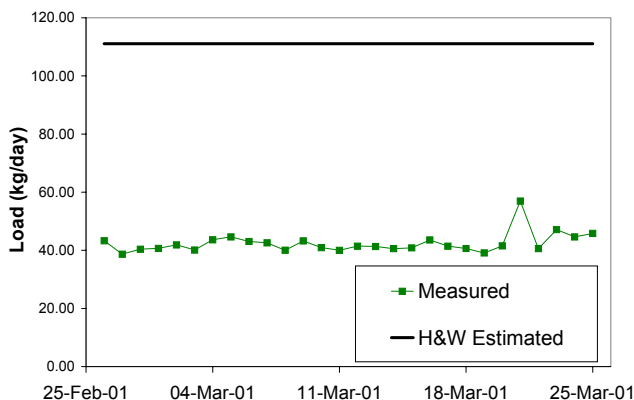
By applying her findings to other sub-watersheds of the Inland Bays Basin, Jennings hopes to provide environmental managers with a better understanding of nutrient cycles and trends to permit development and improvement of watershed land use practices, thereby reducing the occurrence and severity of eutrophic events.

(See next page for preliminary findings)

(Jennifer Jennings, continued from page 5)

Of some preliminary findings (below), she says "A hydrological balance suggests that a substantial fraction of the water from the Bundicks Branch watershed discharges through the groundwater below our surface water gauging station. As a result, measured nitrogen loads at the gauging station underestimate the true measured nitrogen loads from the watershed to the Inland Bays, which may be comparable to the Horsley & Witten estimates." For more information, contact Jennings at jenjen@udel.edu.

Daily Nitrogen Loads at Bundicks Branch



DWRC Announces 2002 - 2003 Undergraduate Interns

Six University of Delaware junior undergraduate students were selected in April by the **Delaware Water Resources Center (DWRC)** Advisory Panel to participate in the 2002 **DWRC** undergraduate internship program. Through **DWRC's** unique program, students and faculty from a variety of disciplines work together in research and education programs addressing water resource related issues of critical importance to Delaware and the Mid-Atlantic region.

Laura Boyer, an Environmental Science major with minors in Spanish and Biology, was a Science and Engineering Scholar with the Undergraduate Research Program this past year. She will be working on "*Chemistry of Phosphorus in the Erodible Fraction of Delaware Soils*", with the goal of more accurate water quality modeling to prevent nonpoint source phosphorus pollution of Delaware's surface waters. Laura's project advisor will be Dr. Tom Sims of UD's Plant and Soil Sciences Department.

Alexander M. DeWire's internship project will study "*Implementation of Riparian Buffers in Southeastern Pennsylvania, Delaware, and Eastern Maryland*" under the advisement of Dr. Janet B. Johnson of the UD Department of Political Science. An Honors Program Natural Resource Management

major minoring in Political Science, Alexander hopes to measure the extent of streamside reforestation by property owners to reduce nonpoint pollution, notably in the Chesapeake Bay watershed, and to develop a means for tracking these efforts by coordinating organizations.

Kerrie Smith, a Mechanical Engineering student minoring in Mathematics and Physics, will team with advisor Dr. James Glancey of the UD Departments of Mechanical Engineering and Bioresource Engineering to study the "*Development of a Real-time Measurement and Monitoring System for Microorganisms in Delaware Waterways*." She aims to develop an "in-field" sensor that can detect potentially harmful aquatic microorganisms, such as pfiesteria and algae, and then integrate her detection methodology into a system capable of recording and transmitting water quality data.

"*Understanding the Mechanisms of the Spread of Phragmites: For Better or For Worse*" is the project **Michael T. League** hopes will provide valuable research experience supporting improved wastewater treatment methodologies as well as wetlands protection and restoration. His internship advisor will be Dr. John L. Gallagher of the UD College of Marine Studies. Michael is majoring in Biological Sciences Education in the Honors Program, with a concentration in Marine Studies.

Kristen A. Sentoff, an Honors Program student and Natural Resource Management major, will be researching aspects of "*Managing Wetlands in Delaware in a Changing Legal Environment*" for her internship. Her project advisor is Dr. Joshua Duke of the UD Department of Food and Resource Economics.

"*Accelerated Pollutant Biodegradation by Electrode Use*" is the title of **Aditya Sharma's** proposed research project on design and use of bioremediation systems. A Howard Hughes Medical Institute Scholar with the UD Undergraduate Research Program last year, Aditya is majoring both in Biochemistry and Biology / Psychology. His advisors are Dr. Steven Dentel and Dr. Pei Chiu of the UD Civil and Environmental Engineering Department.

UD Marine Studies Students Land Prestigious Marine Policy Fellowships

Gerhard Kuska and Gonzalo Cid, doctoral students in the UD Marine Policy Program, are among 37 nationwide receiving prestigious 2002 Knauss Marine Policy Fellowships. They will work for one year at a Washington DC government agency. For details, see <http://www.ocean.udel.edu/newscenter/knauss02.html>

2002 DWRC Annual Meeting and Undergraduate Interns Poster Session

The 17-member *DWRC Advisory Panel* convened for lunch and their annual meeting on April 19 on the UD campus. *DWRC* Director Tom Sims described the Center's plans for 2002 with regard to research funding and public education through *WATER NEWS* and the newly established *DWRC* web site. The panel discussed ways to enlist support for research and training efforts in water resources that are led by the *DWRC*.

The *DWRC*'s seven 2001 undergraduate interns were invited to present posters of their project findings with their advisors at an informal session sponsored by the UD Undergraduate Research Program following the Advisory Panel lunch. More than 80 Science and Engineering Scholars joined the *DWRC* interns to present to a crowd in excess of 450 visitors.

One of the seven, Tara Harrell, also recently gave an oral presentation on her project "*Research Connecting the Link between Stream Quality and Land Use in the University of Delaware Experimental Watershed*" at the annual proceedings of the National Conference on Undergraduate Research on April 26 at the University of Wisconsin-Whitewater.



Nutrient Management News
A regular update on Delaware's
Nutrient Management Program
<http://www.state.de.us/deptagri/nutrients/index.htm>

The *DWRC* is supporting three 2000-2003 graduate fellowships that provide scientific support to the *Delaware Nutrient Management Commission (DNMC)'s State Nutrient Management Program*. This program is designed to improve water quality in Delaware while preserving valuable agricultural industries through cost-sharing programs, the approval of alternative-use projects, the education of nutrient generators and handlers, and many other measures.

In its April 2002 Annual Report to Governor Minner, the *DNMC* summarized progress made in 2001 toward its stated priority goals:

- **Development of regulatory standards** for the Concentrated Animal Feeding Operation (CAFO) permit program continues, affecting large facilities such as poultry farms raising more than 100,000 birds.

- **Nutrient planning support and education** included 70 free classes providing 4 levels of nutrient management certification and 15 nutrient management seminars for all sectors of the agriculture industry and commercial nursery, turf, and landscape industries, all conducted by the UD College of Agriculture and Natural Resources. More than 1500 participants are actively pursuing or have been issued a nutrient management certification, and sixty people representing 27 companies and organizations are now certified as nutrient management consultants. Nutrient management plans were established for more than 122,000 acres during 2001, bringing the total to date to nearly 200,000 (40%) acres of agricultural crop land. Cost-sharing has defrayed costs of this planning for more than 177,000 acres to date, and the *DNMC* is also offering reimbursement for soil sampling and manure testing.

- *DNMC*-identified priority action areas for **relocation of excess animal nutrients** (manure) now encompass about 70% of Sussex County, including the Inland Bays and the Nanticoke and Pocomoke watersheds, based on *DNREC*'s impaired-waters list and livestock production levels. Cost assistance has been provided to relocate more than 48,000 tons of excess poultry manure to date, 30,000 tons of which were exported off the Delmarva Peninsula, with the balance used in areas in need of nutrients or alternative use projects processing raw manure into economically and environmentally sound products. For example, the new Perdue AgriRecycle Pelletizing Plant has processed and exported approximately 15,000 tons of Delaware poultry litter.

- **Promotion of Best Management Practices** positively impacts water quality in the short and long term. Cooperation among farmers, county conservation districts, and the *DNMC* has brought about the publication of a source book containing 53 recommended practices, such as testing soil before fertilizing, using proper timing and methods for both commercial and manure fertilizer applications, planting cover crops and vegetative buffer strips, controlling erosion, disposing of dead animals properly, and using general conservation practices. Structural best management practices have been supported by the *DNMC* as follows:

Conservation Practices	New Castle County	Kent County	Sussex County
Manure storage structures	3	10	52
Poultry carcass composters	0	6	28
Acres under conservation plans	10,625	14,630	16,268

**The Delaware Water
Resources Center**

The Delaware Water Resources Center (DWRC), established in 1965, is part of a network of 54 Water Resources Research institutes throughout the nation. The DWRC receives funding through Section 104 of the Water Resources Research Act of 1984. The U.S. Geological Survey administers the provisions of the Act and provides oversight of the nation's Water Resources Centers. The primary goals of the DWRC are: to support research that will provide solutions to Delaware's priority water problems, to disseminate research results to water managers and the public, and to promote the training and education of future water scientists, engineers, and policymakers. For further information, visit our website:

<http://ag.udel.edu/dwrc/>

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