Human Exposure Hazards of WNS Decontamination

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Abstract

White Nose Syndrome (WNS) is a disabling and often fatal symptom of illness in bats that is caused by the Geomyces destructans fungus. Spores of this fungus are environmentally resistant and thus relatively long lived in nature. Further, they have low susceptibility to deactivation by detergents used historically for cleaning caving equipment. Research has established a group of chemicals known, under specific usage, to deactivate the G. destructans spores. Procedures incorporating these chemicals are effective for decontaminating caving equipment. However, all chemicals on the list pose potential, but avoidable, risks to human health during the decontamination procedure. Exposure routes during decontamination include inhalation, skin contact, splash to the eyes, and accidental ingestion. Use of personal protective equipment in a well-ventilated area will mitigate most or all of the risks to these chemicals. Procedures are presented in this talk to improve safety for those who may face potential chemical exposures during WNS decontamination.

White Nose Syndrome

- Geomyces destructans fungus
- First observed on bats in Howe's Cave, NY February 2006 (Blehert et al. 2009)
- Significant mortality in bats of many species (Gargas et al. 2009)
- Estimates of hundreds of thousands of bats have died as a result of infection from G. destructans

Fungi Genus: Geomyces

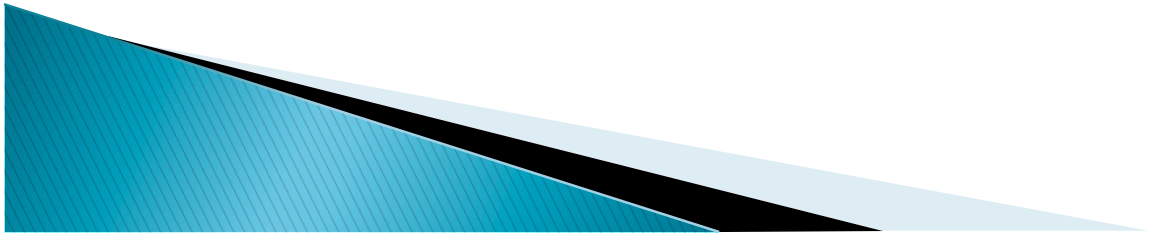
- Very common
  - Caves and mines
  - Found as far south as Antarctica (in soil)
- Isolated from cave crickets and bat hibernacula
- Cause of minor skin and nail infection in humans (Geomyces pannorum)
- One species of which causes infections in bats…

Geomyces destructans

- Reported by Gargas et al. (2009) as associated with White Nose Syndrome in bats
  - Little Brown, Big Brown, Northern Long Ear, Tri-color Bats
- Also found in Indiana Bats, Cave Myotis, and Gray Bats
- Cave Myotis shares roosts with "…gray myotis, Mexican free-tailed bats, eastern pipistrelles, and Rafinesque's big-eared bats." (Texas Parks & Wildlife, 2009)
- Most recently confirmed in Southeastern Myotis (Reynolds & Fernald, 2010)

How can it be spread?

- Humans MAY spread it… this has not been confirmed, but is a possibility
  - Precautions needed in order to not spread G. destructans and OTHER potentially harmful biological agents
- Bats DEFINITELY spread it



Humans who MAY spread G. destructans

- Recreational Cavers and Mine Visitors
- Biologists
- Geologists
- Archeologists
- Government regulatory officials
- Tourists (commercial caves and mines)

How do we know if we're carrying it?

- Extremely difficult
- Samples from all of our gear, clothing, skin, etc.
  - Culture the samples
  - DNA testing to confirm
- ASSUME we're carrying it and do decontamination to reduce possibility of spreading

Development of Decontamination Procedures

- Calls for procedures came early after infection was observed
- Research conducted by a number of microbiology researchers to find effective disinfectants
- Formal decontamination procedures presented in summer of 2009 (USFWS, 2009)
- Evaluation of decontaminants' effectiveness on killing/deactivating G. destructans fungus and spores (Barton et al. 2010)

June 2009: United States Fish and Wildlife Service "Procedures for Cavers"

- Chlorine Bleach
- Lysol Professional Antibacterial Cleaner
- Sparquat 256
- Promicidal
- Grenadier
- Formula 409
- Woolite
- Dawn Antibacterial Hand Soap
- Purell
- Lysol Disinfecting Wipes
- 70-95% ethanol

USFWS 2009 List

Method	Conditions	Kill Time	Health Effects	PPE
Disinfectant				
5.25% Chlorine bleach	10% bath solution (1 part bleach: 9 parts water)	10 min	Inactivatedby organic material, detergents; corrosive to metals; produces toxic gas if combined with ammonia; skin irritant	***Impermeable Gloves (> 4 mil thickness):*** Butyl Rubber, Natural Rubber, Nitrile, Polyeth-ylene, PVC, Viton ***Goggles or Face Shield***
Ly sol® Professional Antibacterial All Purpose Cleaner	1:128 bath solution (1 oz per 1 gal water)_	10 min	Corrosive; skin & eye irritant	***Gloves (> 4 mil thickness):*** Butyl Rubber, Nitrile, Polyeth-ylene, PVC ***Goggles or Face Shield***
	1:64 bath solution (2 oz per 1 gal water)	5 min		
Sparquat 256	½ oz per 1 gal water	10 min	Serious risk, corro-sive, irreversible eye damage, skin burns, irritating to respira-tory system	***Gloves (> 8 mil):*** Rubber ***Goggles or Face Shield***
PromicidalTM (Phenocide 128, Promicidal was cancelled April 30, 2008)	1:128 bath solution (1 oz per 1 gal water)	10 min	Contains a known carcinogen, harmful to aquatics, avoid use	***Gloves (> 8 mil):*** Rubber ***Goggles or Face Shield***
GrenadierTM (MAQUAT TC)	1:64 bath solution (2 oz per 1 gal water)	10 min	Requires hazardous waste disposal methods, irritates mucous membranes, corro-sive, severe eye damage, paralysis, circulatory shock	***Gloves (> 8 mil):*** Rubber or neoprene ***Goggles or Face Shield Impervious Apron***
	1:32 bath solution (4 oz per 1 gal water)	5 min		
Formula 409®	At least 0.3% concentration	10 min	Eye irritant, use in well-ventilated area	***Gloves (4 mil):*** Nitrile ***Goggles***
Woolite®	Four tablespoons in one gallon of water	Use during wash cycle in	Very low toxicity	***Gloves (4 mil):*** Nitrile for extended exposure
Dawn® antibacterial hand soap	Refer to product label	Use during gear scrubbing	Irritating to skin after repeated exposures	***Gloves (4 mil):*** Nitrile for extended exposure
Purell	Refer to product label	Disinfecting scrub-bed gear	Irritating to skin after repeated exposures	***Gloves (4 mil):*** Nitrile for extended exposure
Ly sol disinfecting wipes	Refer to product label	Disinfecting scrub-bed gear	Irritating to skin after repeated exposures	***Gloves (4 mil):*** Nitrile for extended exposure

USFWS Recommended Products (Coleman and Rayman, June 2010)

- Chlorine Bleach
- Lysol Professional Antibacterial Cleaner
- Formula 409
- Lysol Disinfecting Wipes

Photo courtesy of US Fish and Wildlife Service

June 2010 United States Fish and Wildlife Service Recommendations

- Lysol® IC Quaternary Disinfectant Cleaner 0.3% quaternary ammonium compound 1:128 dilution or 1 oz:1 gal water

- Alcohol-based disinfectants NO LONGER RECOMMENDED

Disinfectants from June '09 USFWS Decon Guide

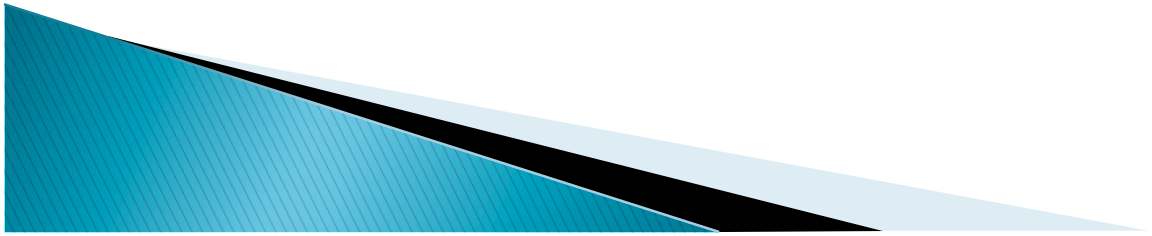
- Major Classes
  - Hypochlorite
  - Quaternary ammonium
  - Phenolics (carcinogens)
  - Alcohols (no longer recommended)
  - Anionic surfactant

Health hazards of exposure

- Hypochlorites – Corrosive, irritant
- Quaternary ammonium – Irritant, anaphylactic, and hypersensitivity rxns
- Alcohols – cause problems for cavers? Well, hmmm…. But for others, irritant, CNS depressant
- Anionic surfactant – dry skin, eczema, urticaria

Routes of Exposure to Humans during WNS Decontamination

- Inhalation
- Skin and Eye contact
- Accidental ingestion

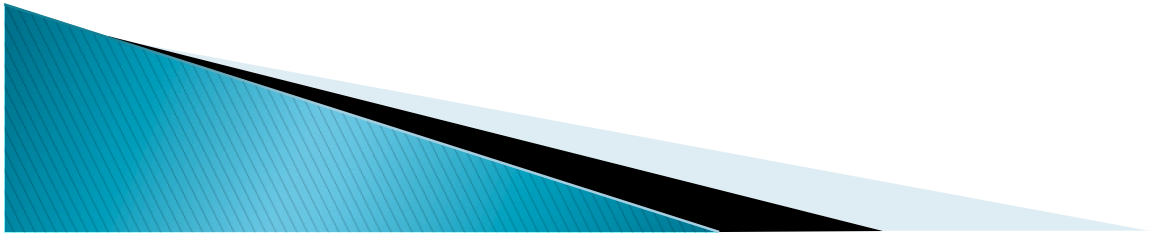


Sodium Hypochlorite (5.25 to 6%) for WNS Decontamination (USFWS, 2009/2010)

- Household “bleach”
- Diluted 1:10 (1 part household bleach to 10 parts water), resulting in a ~0.5% concentration
- Cleaned and scrubbed gear (no dirt remaining) is soaked in the 1:10 solution (0.5% concentration) for at least 10 minutes

Sodium Hypochlorite Human Health Hazards

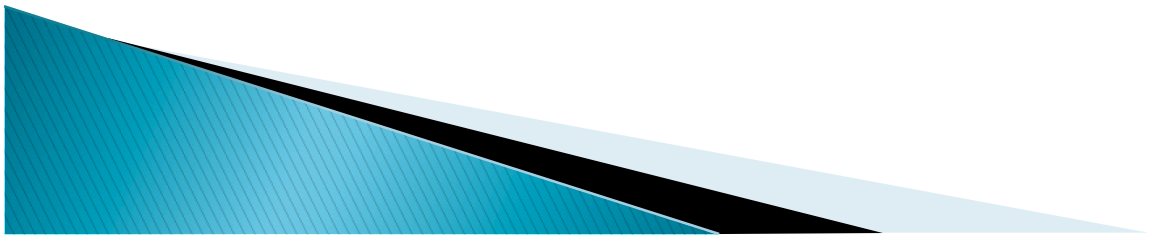
- Respiratory System: Corrosive and irritating to lungs and tissues of the respiratory tract
- Eyes: Corrosive and irritating
- Skin: Permeator, corrosive, and irritating
- Stomach and digestive tract: Irritating



Result of severe exposure to high concentration of corrosive skin irritant

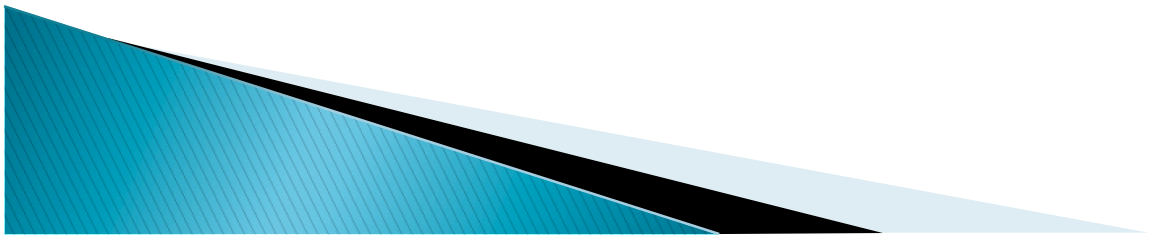
Sodium Hypochlorite Best Practices

- DO NOT MIX WITH AMMONIA
- Minimize contact with metals
- Inactivated by organic-based materials
- Severe toxicity in animals and plants
  - DO NOT DUMP INTO ENVIRONMENT



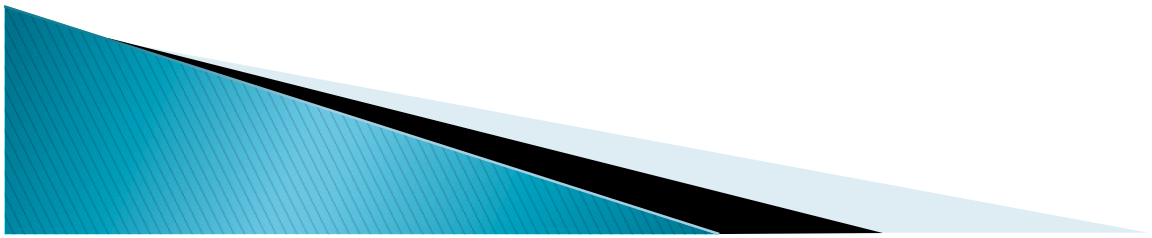
Sodium Hypochlorite Personal Protective Equipment

- Wear gloves (butyl rubber, nitrile, or PVC)
- Wear goggles
- Use in well-ventilated area only!!



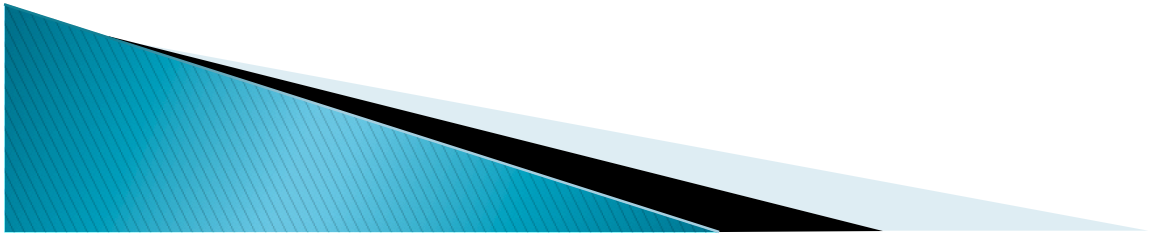
Quaternary Ammonium

- Alkyl dimethyl benzyl ammonium chloride
  - aka: benzalkonium chloride, Lysol wipes, Lysol IC Quat, Sparquat 256, Maquat 256, Formula 409 Antibacterial
- Dialkyl dimethyl ammonium chloride
  - Sparquat 256
- Dioctyl/Didecyl Dimethyl Ammonium Chloride
  - Maquat 256



"Quats" Used in WNS Decontamination

- Quaternary ammonium disinfectants come in a range of concentrations
  - Follow manufacturers' recommendations on dilutions to use
  - Quats are active at 400 PPM, so dilutions will be based on the concentration of the product you have
- For Lysol® IC Quaternary target concentration is 0.3% quaternary ammonium compound, which is a 1:128 dilution or 1 oz:1 gal water
- Quaternary-based wipes, use at full strength



Quaternary Ammonium Human Health Hazards

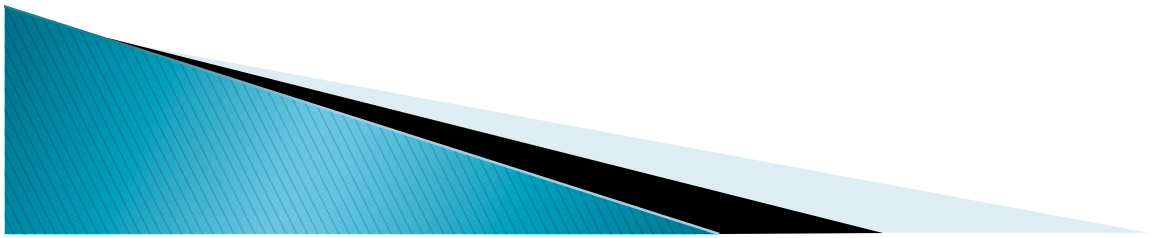
- Respiratory System: Irritating to lungs and tissues of the respiratory tract, possible disruption of lung surfactant for clearing foreign materials
- Skin and Eyes: Known irritant
- WILL CAUSE DEATH IF HIGH CONCENTRATIONS ARE TAKEN INTERNALLY

Quat Ammonium Best Practices

- DO NOT MIX WITH OTHER DISINFECTANTS
  - Will neutralize the Quaternary Ammonium
- Some concentrations and types will REQUIRE wastewater or hazardous waste treatment
- Do not use with “hard” water
  - Quat will be neutralized

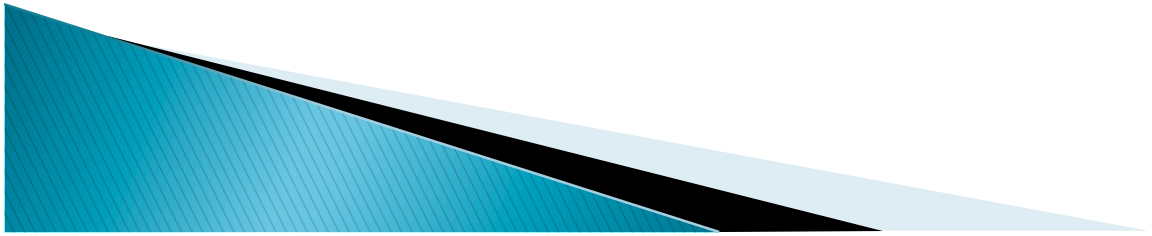
Quaternary Ammonium Personal Protective Equipment

- Wear gloves (butyl rubber, nitrile, or PVC)
- Wear goggles
- Use in well-ventilated area only!!
- Don't ingest



Anionic Surfactant

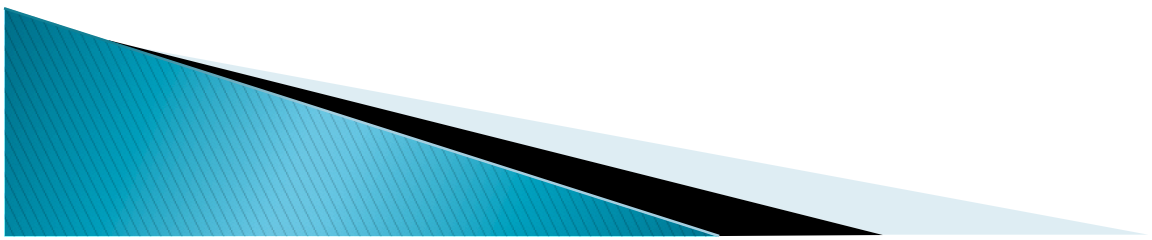
- Tradename: Woolite
- At this time, there are no known serious adverse health effects from exposure to Woolite
- Long-term exposure may result in some irritation, if so, wear nitrile gloves when using and/or minimize contact time with skin



Phenolics

- Ortho-benzyl-para-chlorophenol
- Ortho-phenylphenol
  - Promicidal
  - Phenocide 128
  - CANCELED APRIL 30, 2008
  - KNOWN CARCINOGENS

- DO NOT USE PHENOL-BASED FUNGICIDES

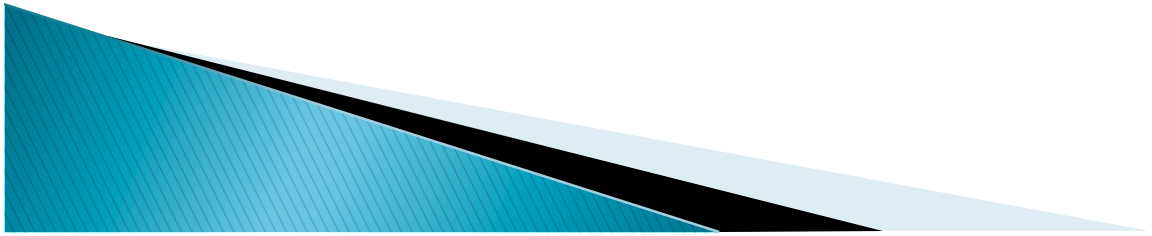


Alcohol-based Disinfectants

- Very common, particularly in hand sanitizers
- NOT EFFECTIVE AGAINST GEOMYCES DESTRUCTANS
- DO NOT USE FOR WNS DECONTAMINATION

General Decontamination Considerations

- Clean water source
- Contain wastewater, dispose in sanitary sewer
- Use lowest effective concentration
- Segregate contaminated gear from clean gear
- Ensure area is well ventilated with steady supply of clean, fresh air
- ALWAYS use gloves and goggles



Specific Decontamination Procedures

- **Field Decon**
  - Hahn, Deirdra (2010, July). WNS-Decon: Something Wicked This Way Comes. *NSS News*, pg. 4.

- **Lab Decon**
  - Coleman, Jeremy and Rayman, Noelle. (2010, June). USFWS White-Nose Syndrome Decontamination Protocols for Researchers, U.S. Fish and Wildlife Service, Region 5, Cortland, NY. National Park Service WNS Workshop, June 9, 2010.
  - http://caves.org/WNS/nps_decontamination_protocols_webinar_june_9_2010.pdf

Other actions that minimize spread AND minimize hazards to health

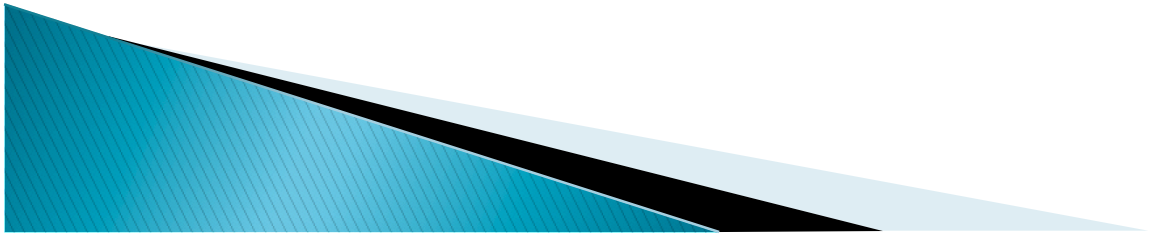
- Limiting the use of cave gear
  - Using different sets of gear for different regions of the country
- Do not use cave gear that has been used in WNS confirmed areas, outside of those areas
- Gear “borrowing” programs like the one at the 2010 NSS Convention
- Gear rental programs

Gear cleaning approach in VA with optional decon for areas not in the Powell River watershed

Caving Protocols in Response to White-Nose Syndrome in Virginia – July 12, 2010 (supplants previous statements)

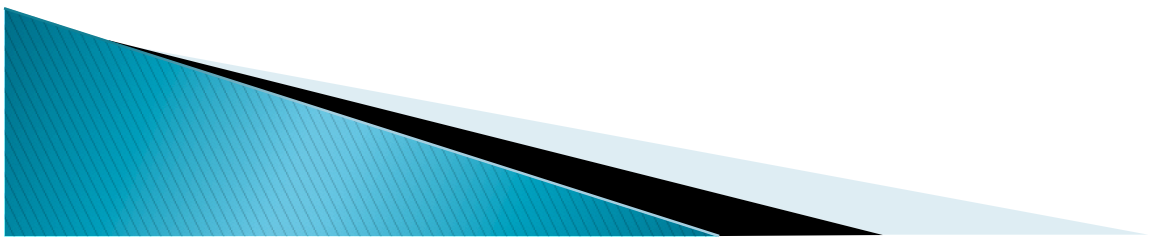
"Cavers are encouraged to thoroughly wash their gear when moving between cave systems within the WNS range to decrease the number of Geomyces spores and other pathogens, contaminants, and organisms transported between caves. Decontamination protocols are available at http://www.fws.gov/northeast/wnscavers.html for those cavers continuing to implement full decontamination procedures."

http://www.dcr.virginia.gov/natural_heritage/documents/wns_recommendations_va_jul_12_10.pdf



What's next?

- We must minimize spread of G. destructans without adverse health effects to humans
- Continue working with cave-related organizations, state and federal government, private landowners
- Do spread the word about effective procedures and encourage everyone to follow them



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Reynolds, Rick & Fernald, Ray. (2010). White-Nose Syndrome Fungus Found on a Different Bat Species in Virginia. http://www.dgif.virginia.gov/news/release.asp?id=261. June 30, 2010. Accessed 07/28/2010.

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WNS Decontamination Procedure

Gather up equipment you may need:

1. Scrub brushes
2. Sponges and washcloths
3. Toothbrushes for scrubbing
4. Small scraping tools for hard-to-reach areas (eyeglass screwdrivers and tweezers)
5. Buckets and small "kid-size" swimming pool
6. Approved decontaminant in proper concentrations (see table)
7. Gloves to protect hands (depends on decontaminant used, see table, probably going to be blue nitrile)
8. Goggles or face shields to protect eyes from splashes of decontaminant

COMMENCE DECONNING!

Don Personal Protective Equipment

1. Put on nitrile gloves with at least 4 mil thickness.
2. Put on goggles.
3. Don't get water or disinfectants inside your gloves and goggles.

Scrub Foreign Material from Equipment

1. Rinse mud, dirt, and minerals from the equipment.
2. If necessary, scrub with a brush to remove larger chunks.
3. Completely rinse equipment.
4. May need to scrub using Antibacterial 409 for really dirty areas.

Apply Decontaminants & Rinse

1. Place submersible gear into a bucket or other container.
2. Soak in solution of 5.25% Sodium Hypochlorite or full-strength Antibacterial Formula 409 for at least 10 minutes. Completely submerge the gear.
3. For non-submersible gear, wipe with 5.25% solution (10:1, results in 0.5% concn) of Sodium Hypochlorite and leave in contact for at least 10 minutes. Lysol disinfecting wipes and Antibacterial Formula 409 may also be used in this step.
4. Thoroughly rinse all equipment to remove any disinfectant residue.
5. Place disinfected equipment in a segregated location within disinfected boxes or bags well away from any potentially infected or dirty gear.

The Disinfectant List...

Method Disinfectant	Conditions	Kill Time	Health Effects	PPE
5.25% Chlorine bleach	10% bath solution (1 part bleach: 9 parts water)	10 min	Inactivated by organic material, detergents; corrosive to metals; produces toxic gas if combined with ammonia; skin irritant	*Impermeable Gloves (> 4 mil thickness):* Butyl Rubber, Natural Rubber, Nitrile, Polyethylene, PVC, Viton *Goggles or Face Shield*
Lysol® Professional Antibacterial All Purpose Cleaner	1:128 bath solution (1 oz per 1 gal water)	10 min	Corrosive; skin & eye irritant	*Gloves (> 4 mil thickness):* Butyl Rubber, Nitrile, Polyethylene, PVC *Goggles or Face Shield*
	1:64 bath solution (2 oz per 1 gal water)	5 min		
Sparquat 256	½ oz per 1 gal water	10 min	Serious risk; corrosive, irreversible eye damage, skin burns, irritating to respiratory system	*Gloves (> 8 mil):* Rubber *Goggles or Face Shield*
PromicidalTM (Phenocide 128, Provincial was cancelled April 30, 2008)	1:128 bath solution (1 oz per 1 gal water)	10 min	Contains a known carcinogen, harmful to aquatics, avoid use	*Gloves (> 8 mil):* Rubber *Goggles or Face Shield*
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	1:32 bath solution (4 oz per 1 gal water)	5 min		
Formula 409®	At least 0.3% concentration	10 min	Eye irritant, use in well-ventilated area	*Gloves (4 mil):* Nitrile *Goggles*
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Lysol disinfecting wipes	Refer to product label	Disinfecting scrubbed gear	Irritating to skin after repeated exposures	*Gloves (4 mil):* Nitrile for extended exposure

Photo courtesy of US Fish and Wildlife Service

Contributors

1. United States Fish and Wildlife Service
2. Liaison on WNS for the National Speleological Society
3. NSS Safety and Techniques Committee
4. NSS 2010 Convention Staff

Additional Information

http://www.caves.org/WNS/

http://www.fws.gov/whitenosesyndrome/

http://www.fws.gov/northeast/whitenose/FINALContainmentandDecontaminationProceduresforCaversJune2009.pdf

Hahn, D. (2010, July). WNS-Decon: Something Wicked this Way Comes. NSS News, pg 4.

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