VIEQUES

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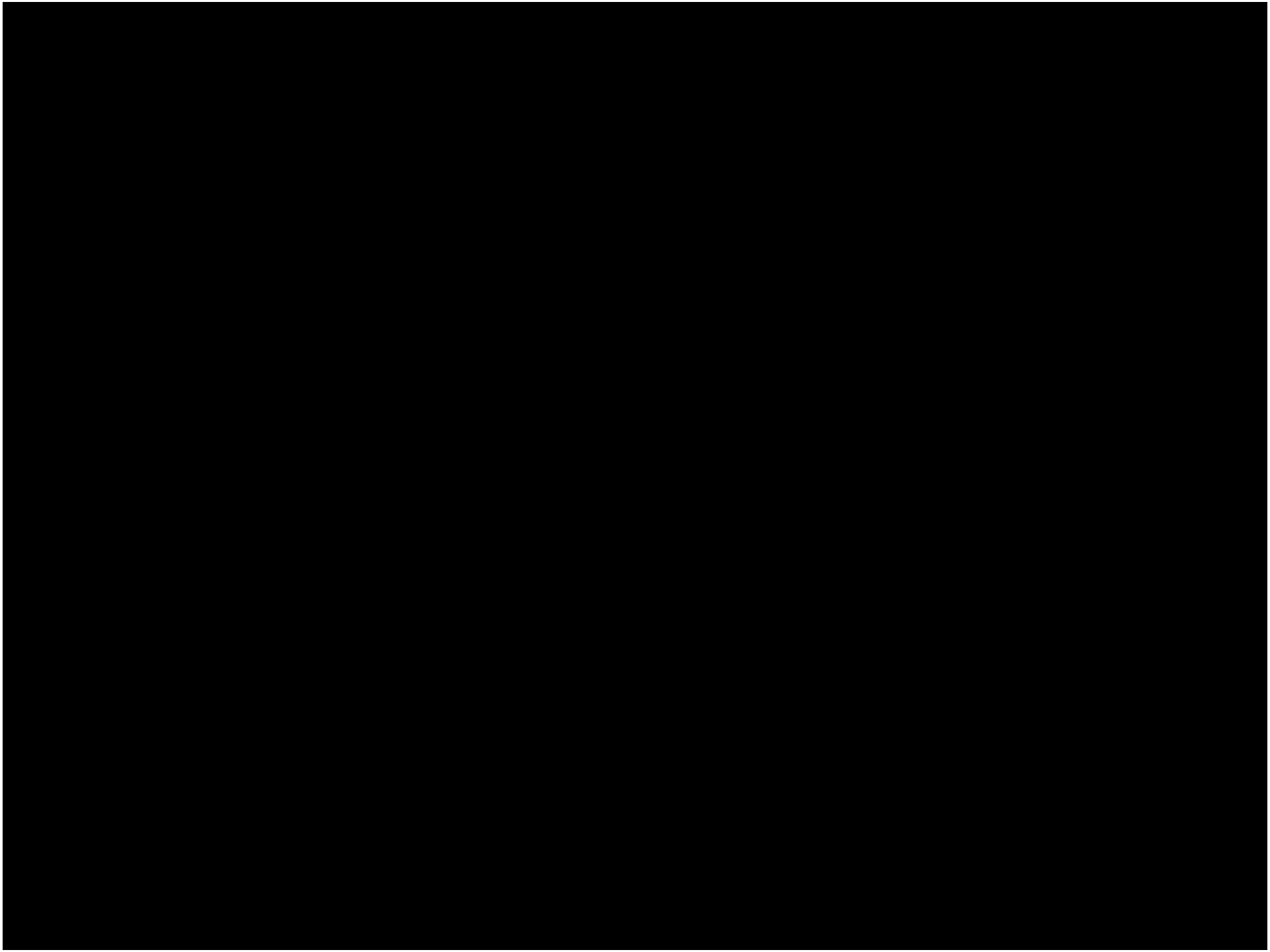
Vieques Island
Vieques Sound
Danger Area
Isabel Segunda
U.S. Navy
Bombing Range
Civilian Section
Esperanza
U.S. Navy
Restricted Area
Danger Area
Restricted Area
Caribbean Sea
© 1992 MAGELLAN Geographix, Santa Barbara, CA

1940-2003

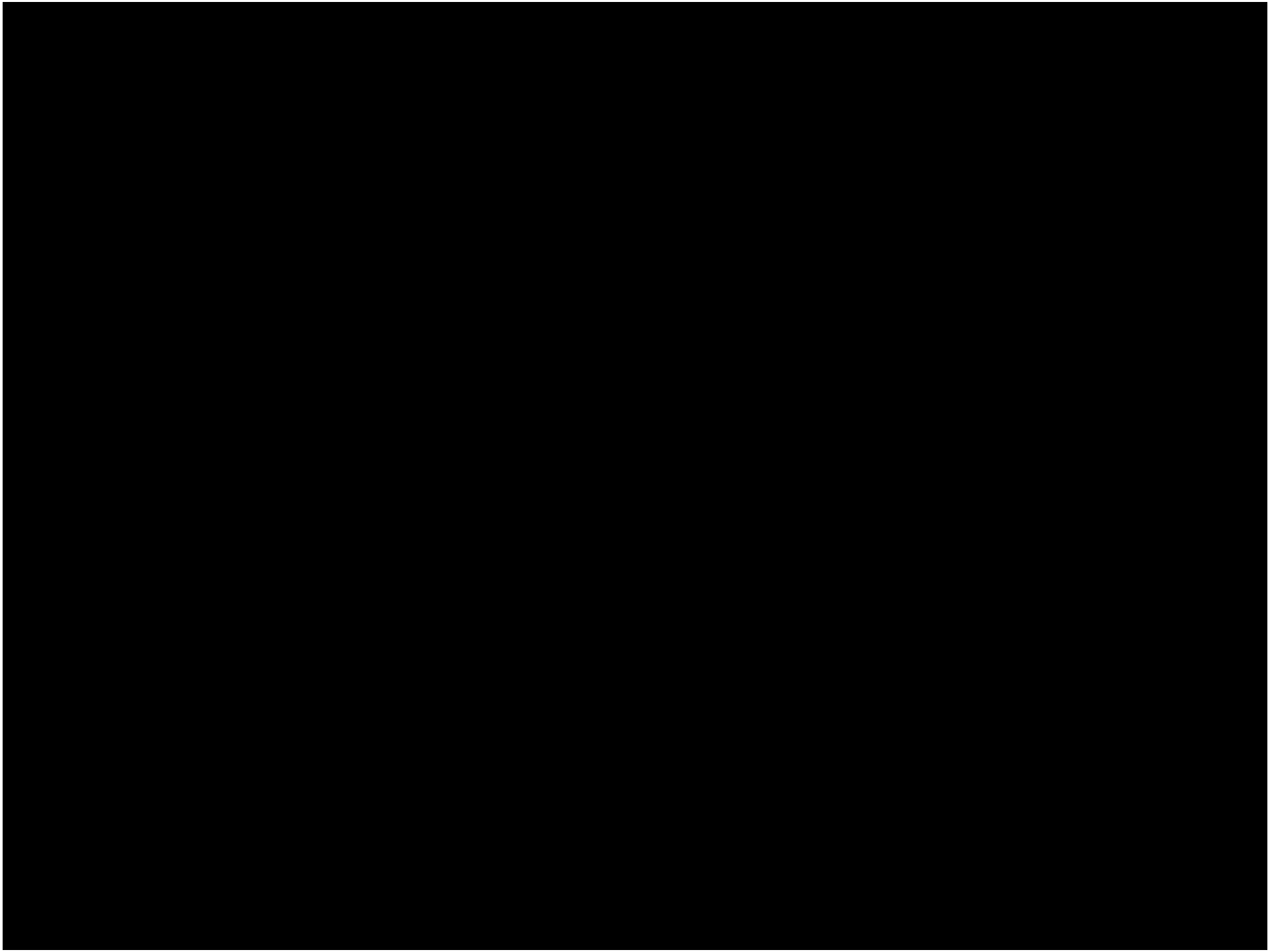


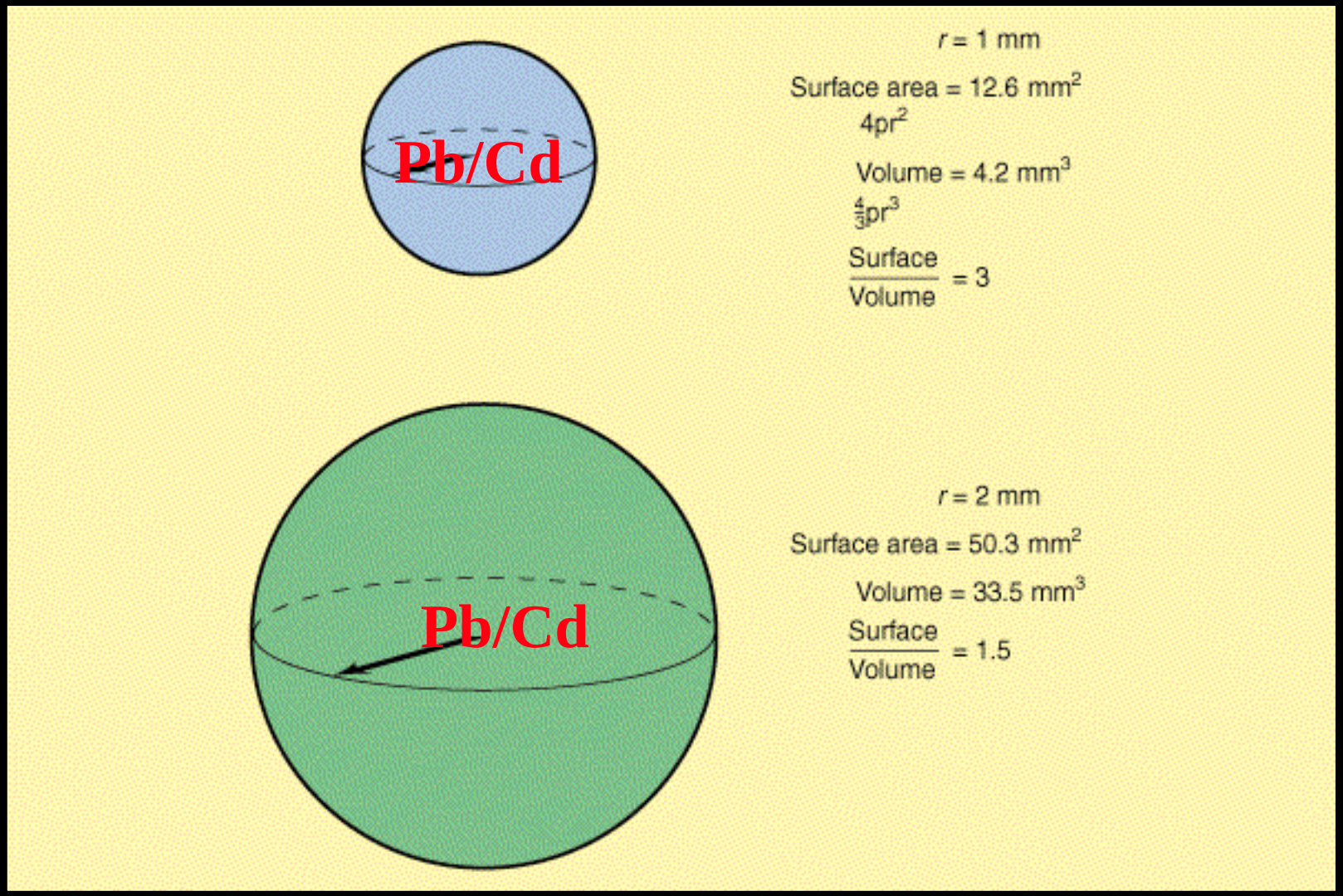
Elements of a Bomb

Acetone
* Acetyl Triethyl Citrate
* Aluminum Powder
* Ammonium Nitrate
Antimony
Barium
* Boron
* Butyl Stearate
Cadmium
Chromium
* Diazodinitrophenol
Diethyl Phthalate
Dimethyl Phthalate
Di-n-butyl phthalate
Di-n-octyl Phthalate
* Dichromated Aluminum Powder

2, 4- Dinitrotoluene
2, 6-Dinitrotoluene
Diphenylamine
* Ethyl Centralite
* HMX
Lead
* Magnesium Powder
Magnesium Alloy Powder
Mercury
Nickel Powder
Nitrocellulose
* Nitroglycerin
* Nitroguanidine
* Nitrostarch
* Pentolite
* Pentaerythritol Tetranitrate (PETN)
* Phosphorous

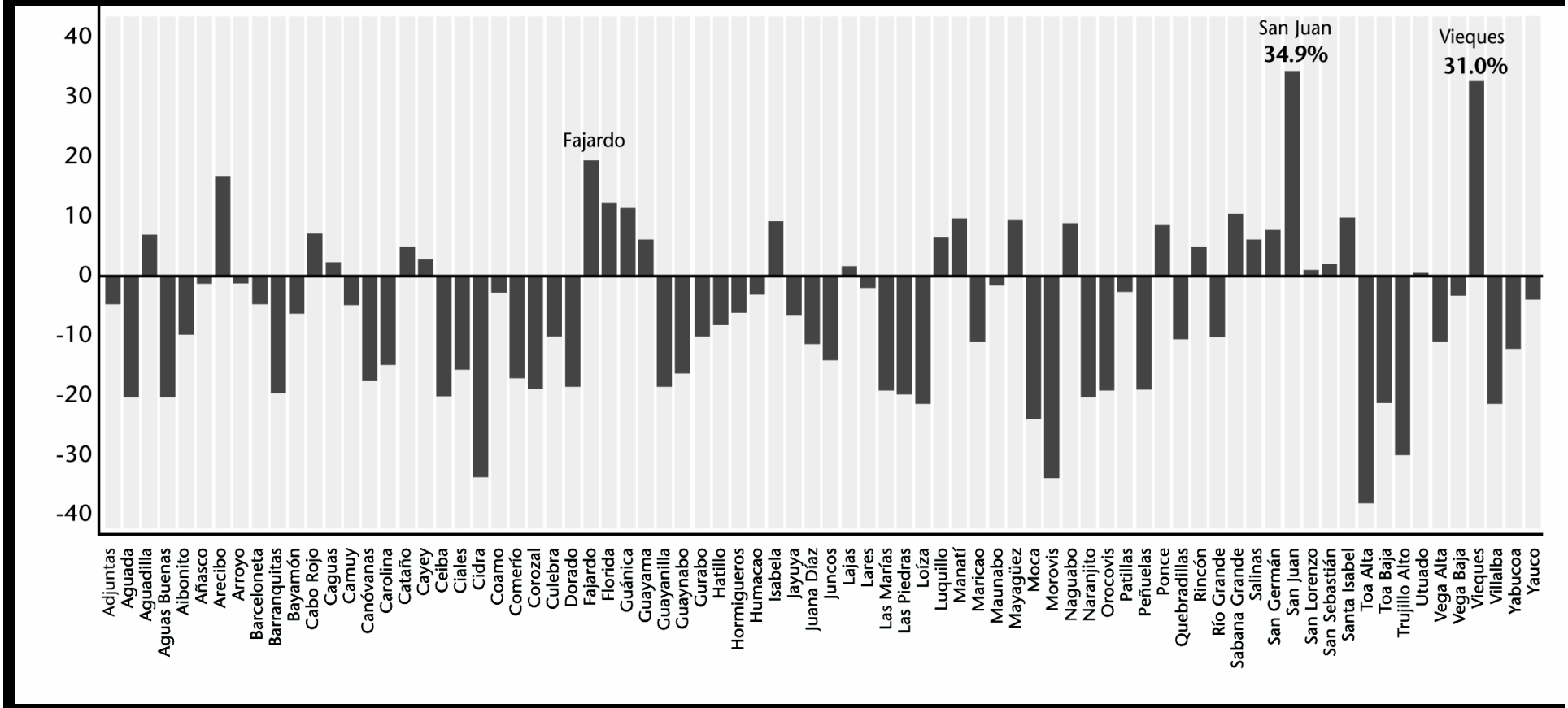
* Potassium Nitrate
* RDX (Cyclonite)
* Resorcinol Selenium
* Sodium Nitrate
* Strontium Nitrate
* Tetracene
* Tetryl
* Titanium Powder
* TNR (Trinitroresorcinol)
* TNT(Trinitotoluene)
* Tri Amino Guanidine NItrate
Vinyl Acetate
Vinyl Chloride
Zinc
* Zirconium Powder



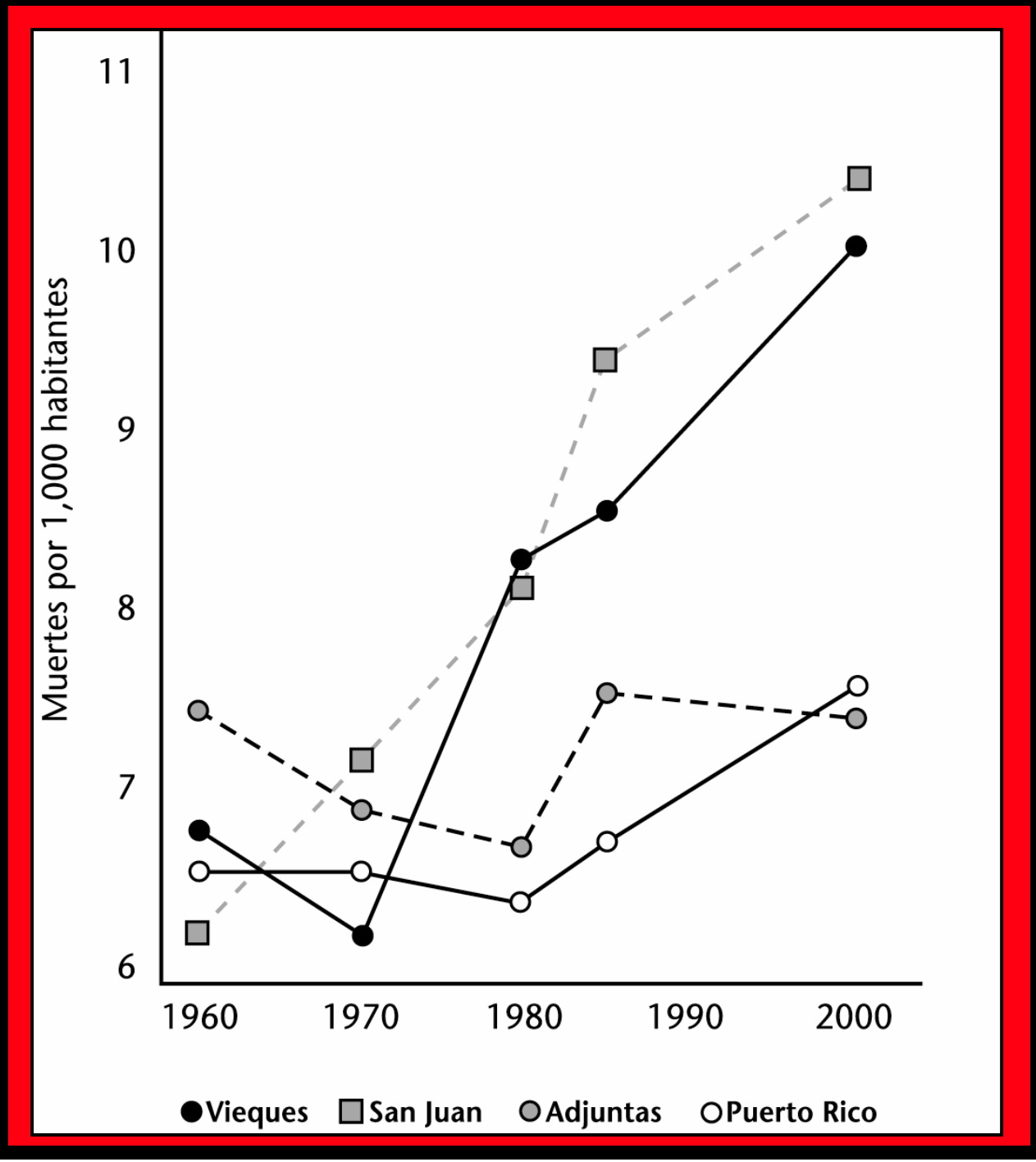


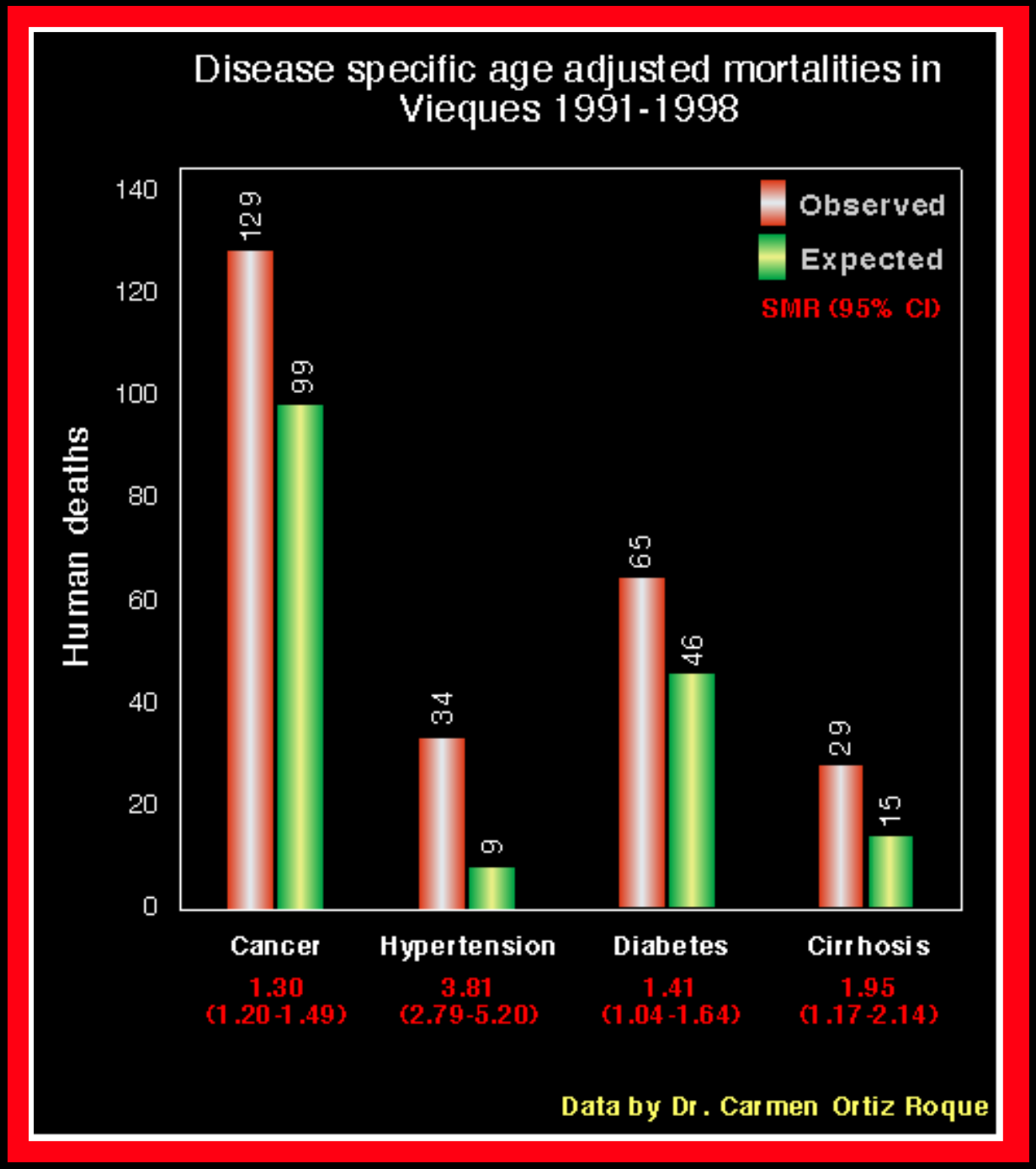
Dispersion of natural trace elements is increased due to military activities.

Is pollution at the Atlantic Fleet Weapons Training Facility contained?


40
30
20
10
0
-10
-20
-30
-40
Fajardo
San Juan
34.9%
Vieques
31.0%
Adjuntas
Aguada
Aguadilla
Aguas Buenas
Aibonito
Añasco
Arecibo
Arroyo
Barceloneta
Barranquitas
Bayamón
Cabo Rojo
Caguas
Camuy
Canóvanas
Carolina
Cataño
Cayey
Ceiba
Ciales
Cidra
Coamo
Comerío
Corozal
Culebra
Dorado
Fajardo
Florida
Guánica
Guayama
Guayanilla
Guaynabo
Gurabo
Hatillo
Hormigueros
Humacao
Isabela
Jayuya
Juana Díaz
Juncos
Lajas
Lares
Las Marías
Las Piedras
Loíza
Luquillo
Manatí
Maricao
Maunabo
Mayagüez
Moca
Morovis
Naguabo
Naranjito
Orocovis
Patillas
Peñuelas
Ponce
Quebradillas
Rincón
Río Grande
Sabana Grande
Salinas
San Germán
San Juan
San Lorenzo
San Sebastián
Santa Isabel
Toa Alta
Toa Baja
Trujillo Alto
Utuado
Vega Alta
Vega Baja
Vieques
Villalba
Yabucoa
Yauco

1998


11
10
9
8
7
6
Muertes por 1,000 habitantes
1960
1970
1980
1990
2000
Vieques
San Juan
Adjuntas
Puerto Rico


Disease specific age adjusted mortalities in Vieques 1991-1998
Human deaths
140
120
100
80
60
40
20
0
Observed
Expected
SMR (95% CI)
129
99
34
9
65
46
29
15
Cancer
1.30
(1.20-1.49)
Hypertension
3.81
(2.79-5.20)
Diabetes
1.41
(1.04-1.64)
Cirrhosis
1.95
(1.17-2.14)
Data by Dr. Carmen Ortiz Roque

Why PLANTS?

- ✓ Transitory receptors of trace elements.
- ✓ Plants can concentrate environmental toxins, thus they can be good bioindicators of environmental degradation.

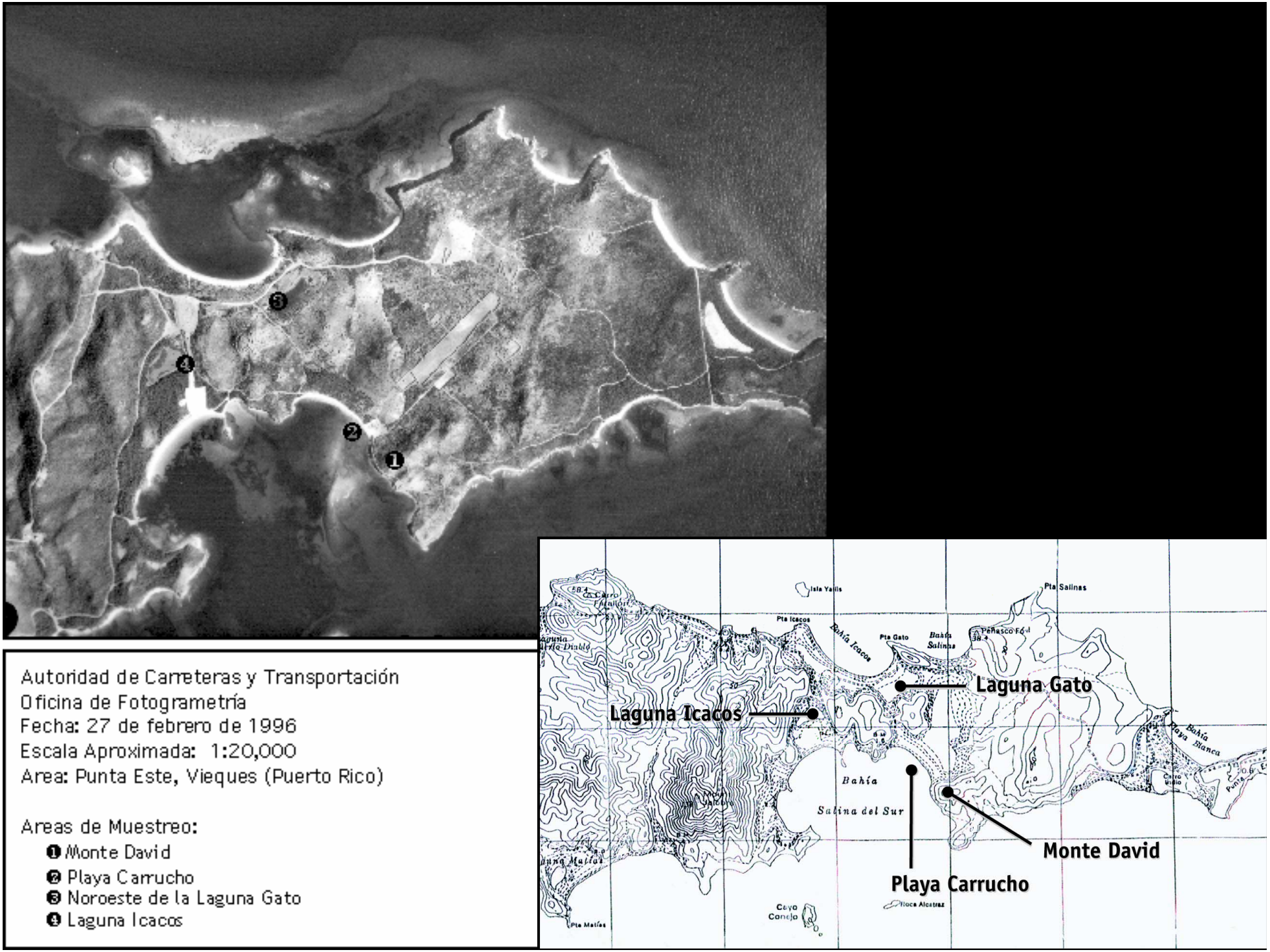
✓Ecological significance: start-up of the food chain.

✓Plants are relatively “immune” to human toxins.
(no diabetes, hypertension or cancer cases have been reported in plants)

Potential use in clean up efforts: **Phytoremediation**

Methodology

- ✓ Life vegetation samples were manually collected.
- ✓ Each station was randomly sampled in a 2 to 5 m^2 circular plot. Sampling sites were independently established for each species. Vegetation analysis always included leaves material. Other plant components were selected as indicated. The sampling was consistently performed by selecting only large, green, healthy looking leaves. Samples from each species consisted of over 30 leaves picked alternately from upper, middle, and the lower sections of 5 to 10 individual plants.
- ✓ Samples were acid digested (2-4 replicates) and analyzed in an atomic absorption spectrophotometer.



Autoridad de Carreteras y Transportación
Oficina de Fotogrametría
Fecha: 27 de febrero de 1996
Escala Aproximada: 1:20,000
Area: Punta Este, Vieques (Puerto Rico)

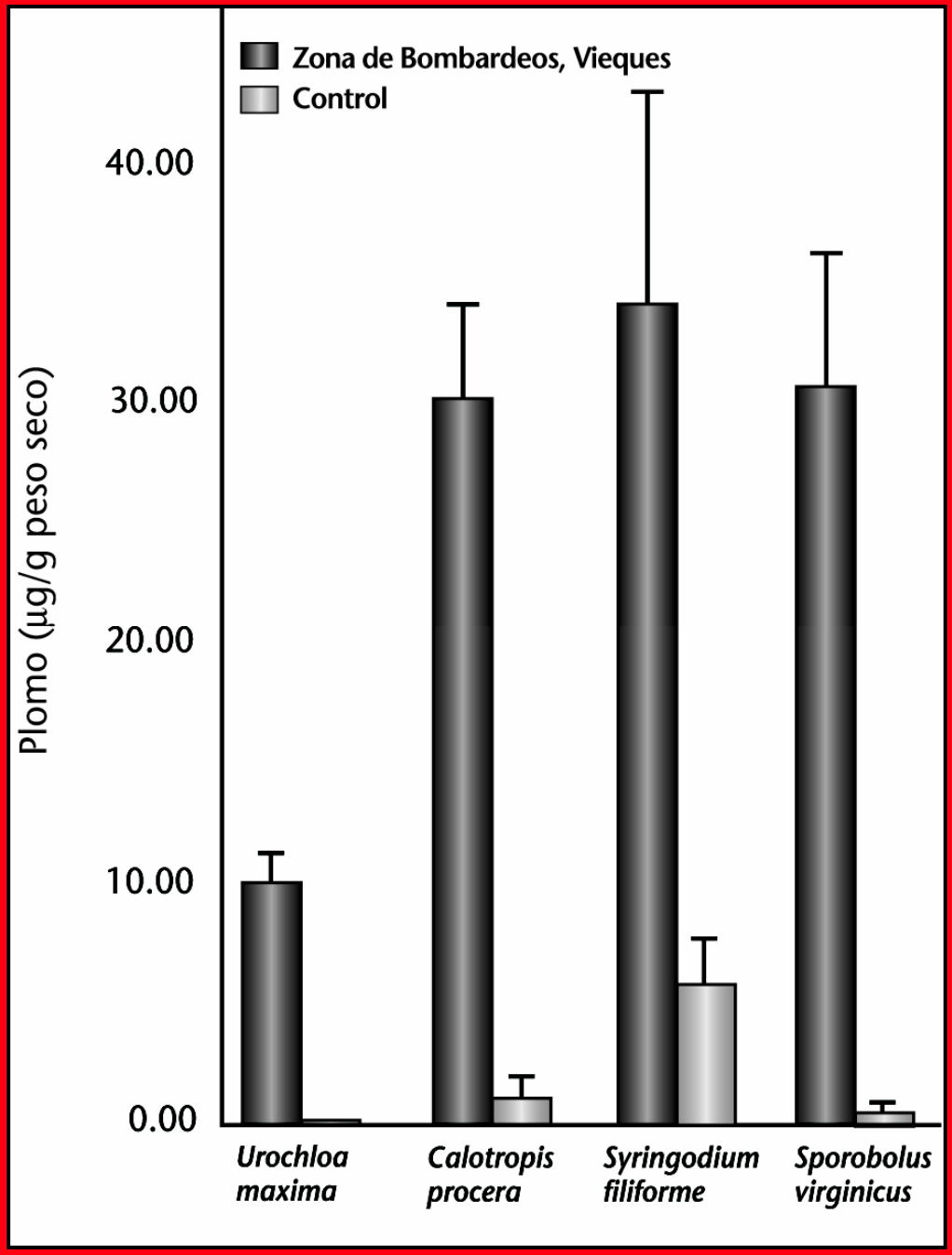
Areas de Muestreo:

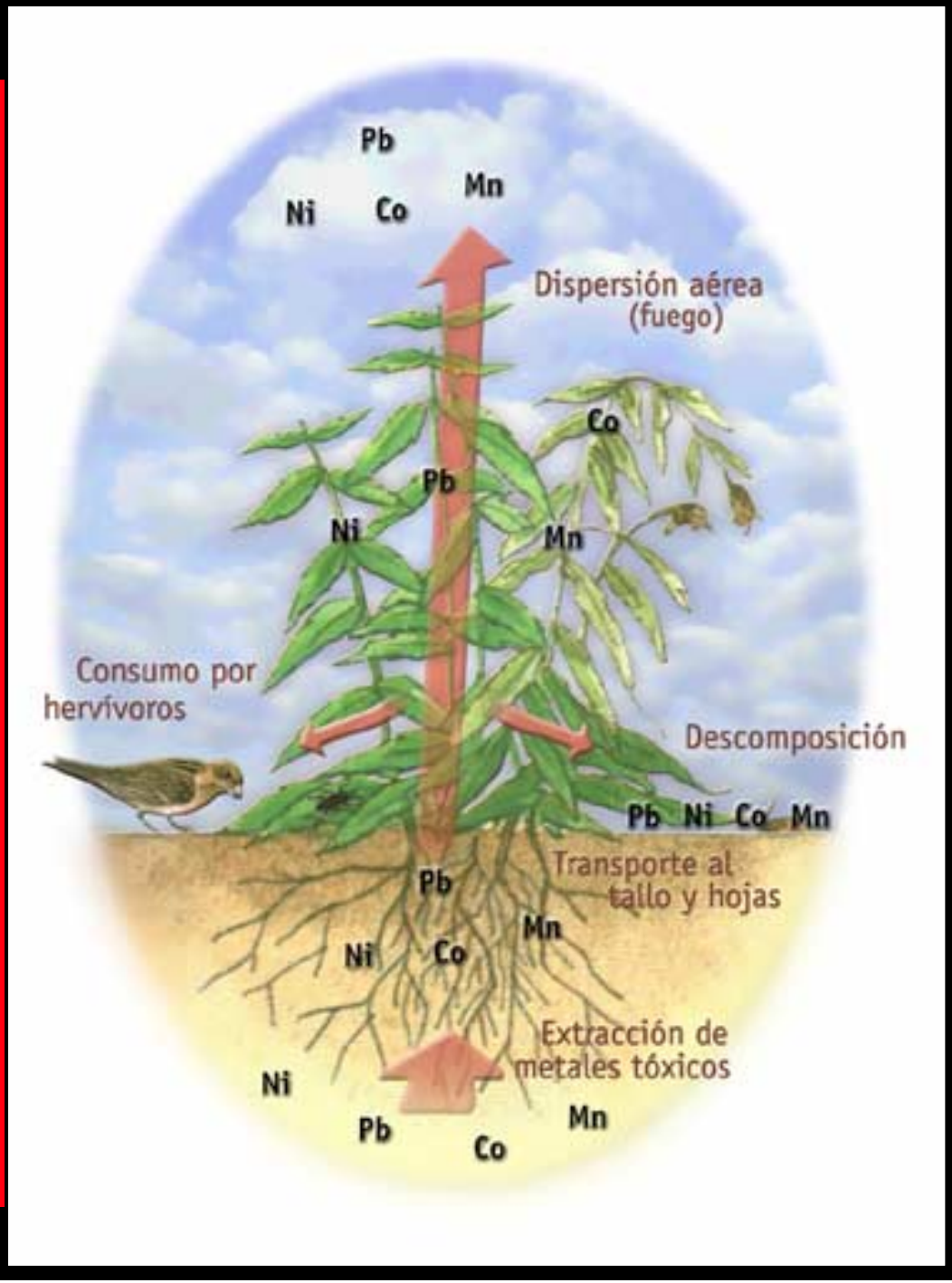
❶ Monte David
❷ Playa Carrucho
❸ Noroeste de la Laguna Gato
❹ Laguna Icacos

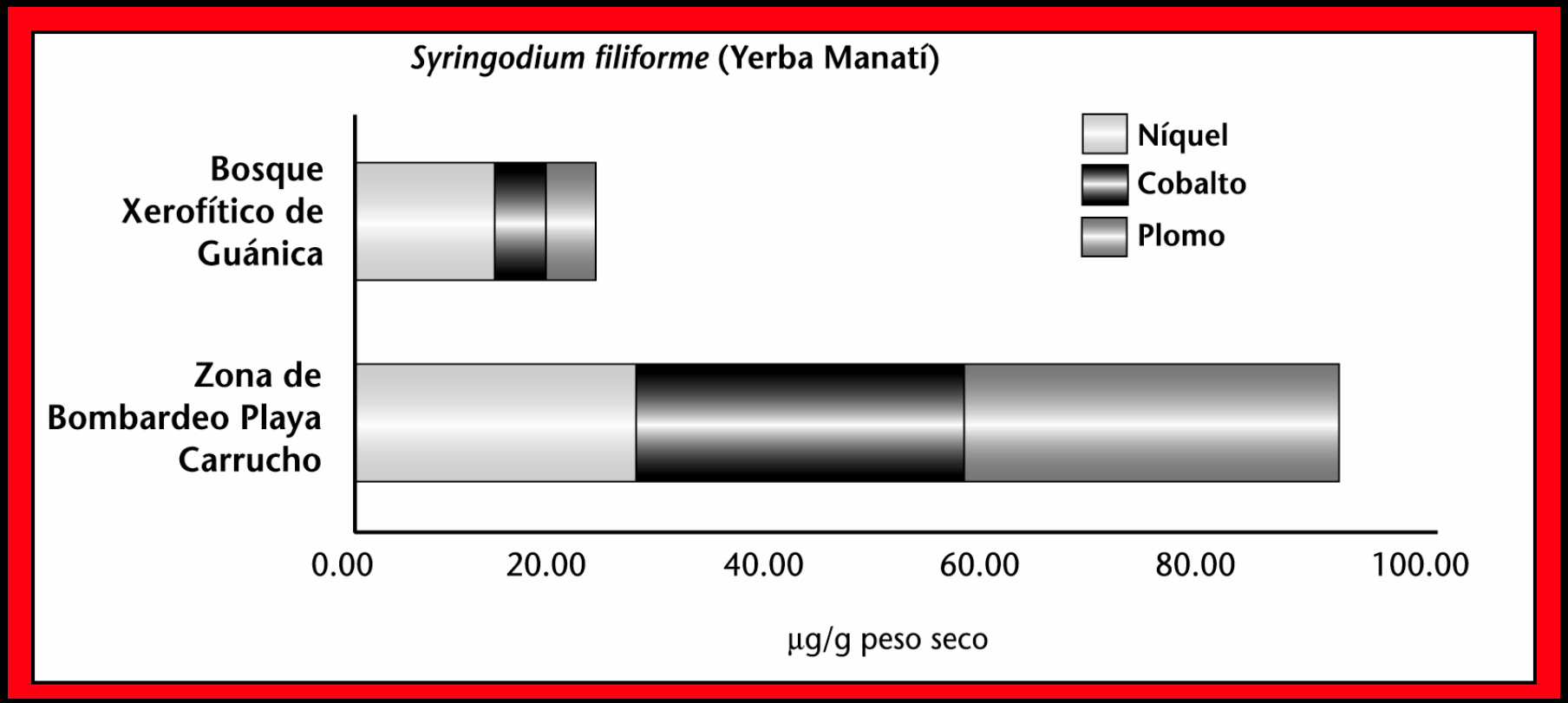
Zonas Bajo Estudio por Massol y Díaz.
CasaPueblo, Adjuntas PR.

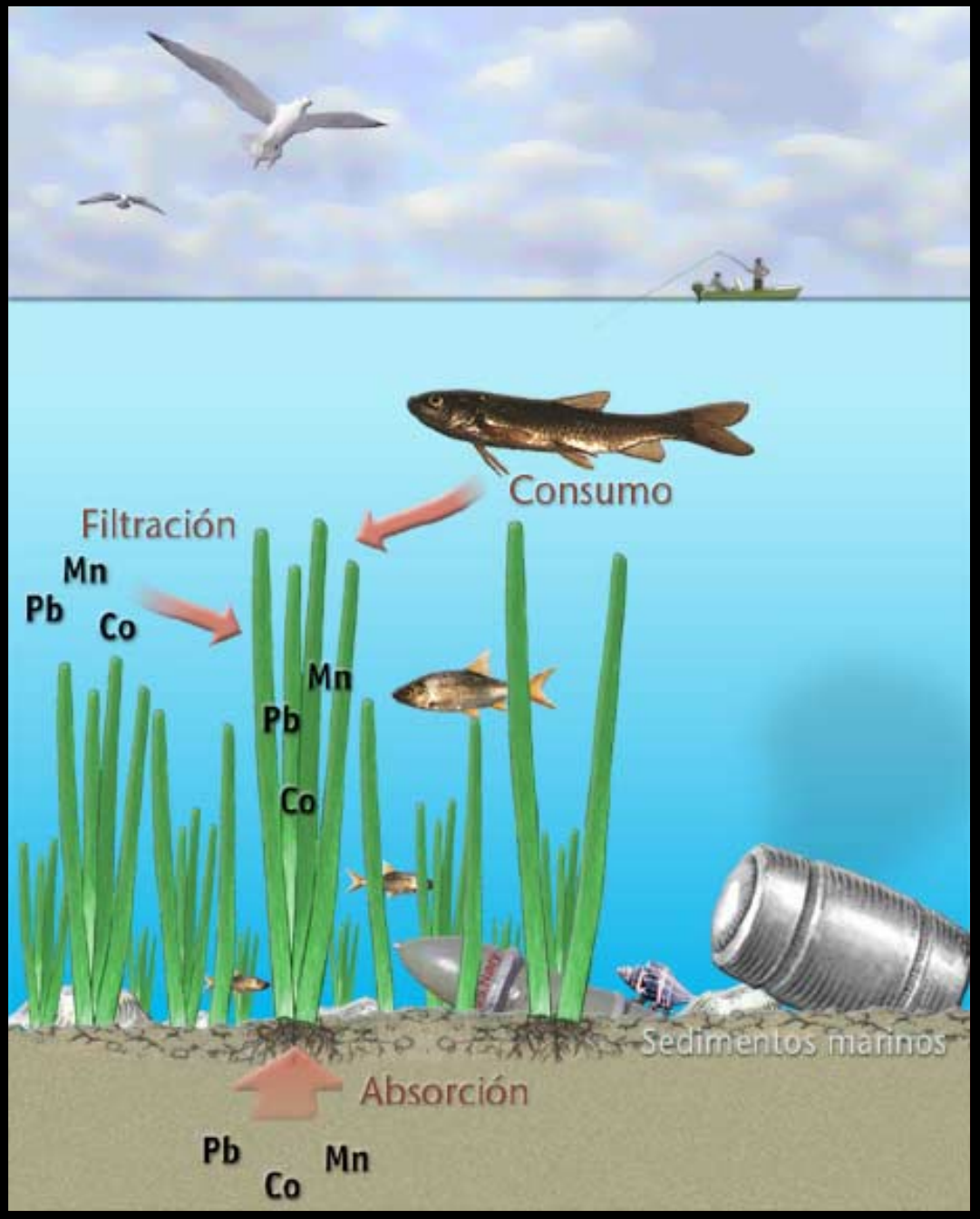
Areas de Muestreo

- (a) Polígono de Prácticas Militares, Vieques
- (b) Zona Civil, Vieques
- (c) Antigua Zona de Prácticas Militares, Culebra
- (d) Bosque Xerofítico de Guánica
- (e) Fincas, Mayagüez y Las Marías
- (f) Zona Industrial, Peñuelas


Zona de Bombardeos, Vieques
Control
Plomo (µg/g peso seco)
40.00
30.00
20.00
10.00
0.00
Urochloa maxima
Calotropis procera
Syringodium filiforme
Sporobolus virginicus


Pb
Mn
Ni
Co
Dispersión aérea
(fuego)
Co
Pb
Ni
Mn
Consumo por
hervívoros
Descomposición
Pb Ni Co Mn
Transporte al
tallo y hojas
Pb
Mn
Ni
Co
Extracción de
metales tóxicos
Ni
Mn
Pb
Co


Syringodium filiforme (Yerba Manatí)
Bosque Xerofítico de Guánica
Zona de Bombardeo Playa Carrucho
Níquel
Cobalto
Plomo
0.00
20.00
40.00
60.00
80.00
100.00
µg/g peso seco

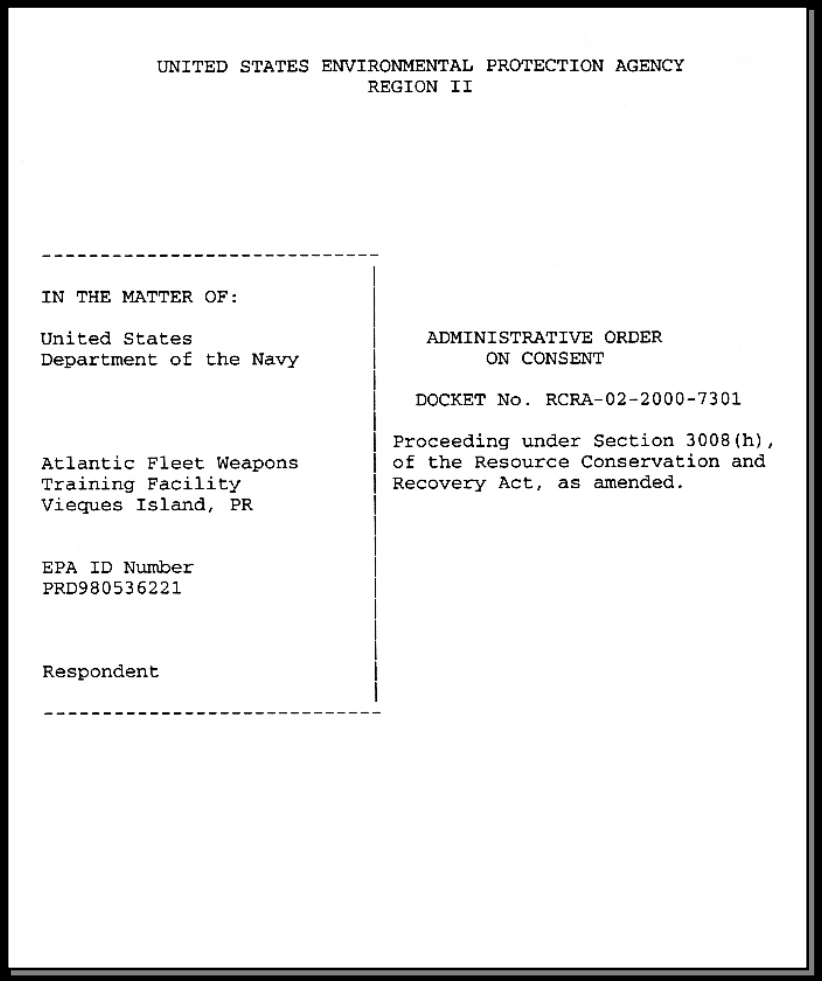

Consumo
Filtración
Mn
Pb
Co
Mn
Pb
Co
Sedimentos marinos
Absorción
Pb
Co
Mn

…analysis revealed sea around Vieques is free of heavy metal contamination!

However, at that time, live ammunition wasn't being used.

However, at that time, live ammunition wasn't being used.

Government Documentation



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II

IN THE MATTER OF:

United States
Department of the Navy

Atlantic Fleet Weapons
Training Facility
Vieques Island, PR

EPA ID Number
PRD980536221

Respondent

ADMINISTRATIVE ORDER
ON CONSENT

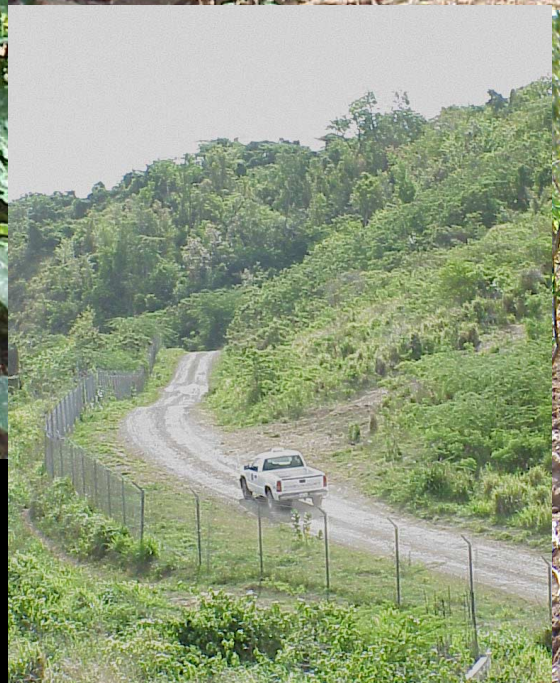
DOCKET No. RCRA-02-2000-7301

Proceeding under Section 3008(h),
of the Resource Conservation and
Recovery Act, as amended.

- In 1994, the EPA identified 102 violations to water quality parameters.
- The EPA Discharge Monitoring Reports identified excessive concentrations of the following contaminants in the coastal waters of Vieques:

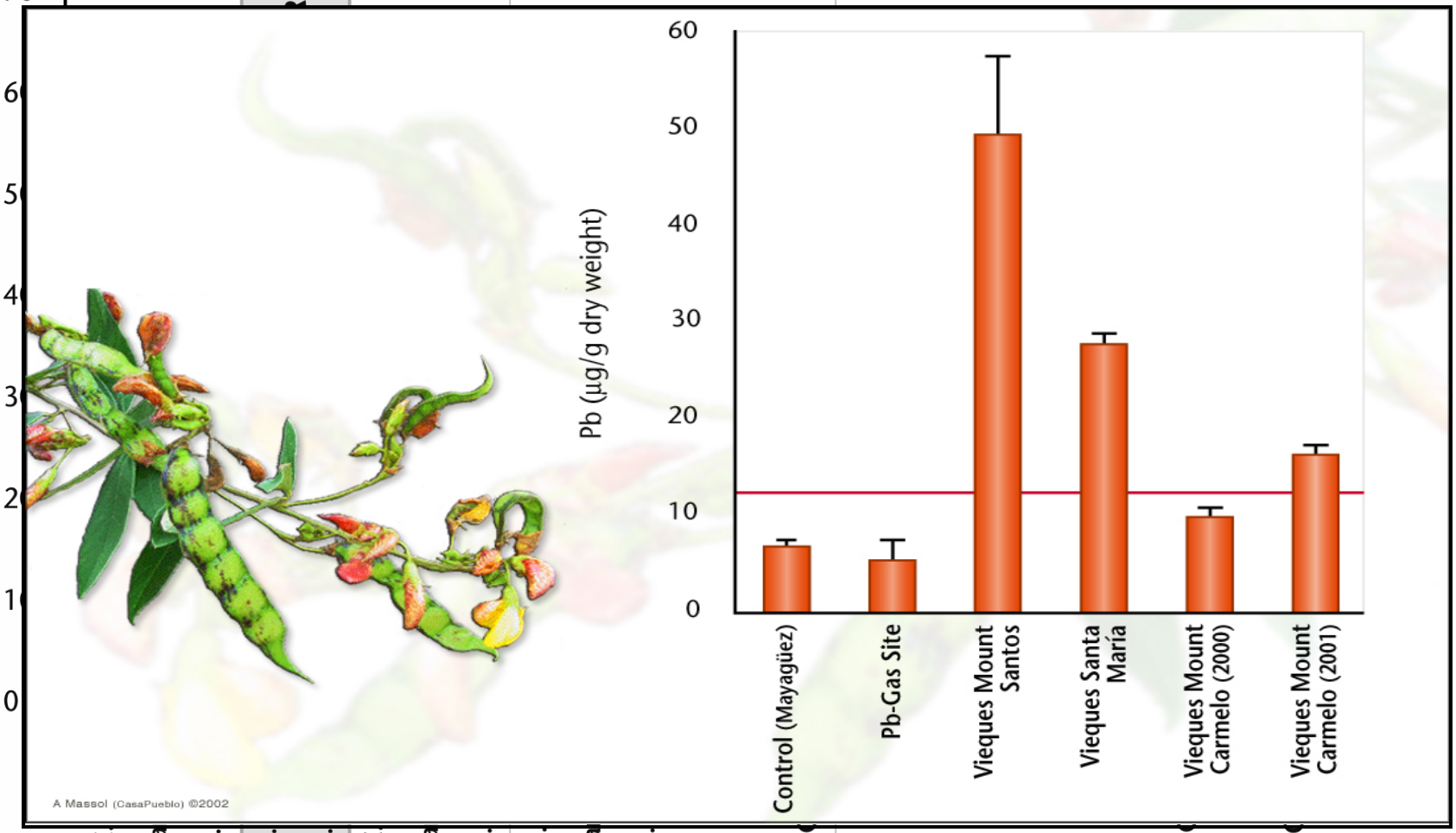
Boron	Cadmium (240x)
Grease	Chromium (13x)
Phenols	Iron
Selenium	Lead (105x)
Silver	Manganese
Sulfates	Mercury (4.6x)
Zinc	Arsenic (6.6x)
Cyanide (10x)	Nitrogen (188x)

	Chemical Element (µg/g DW)						
	Pb	Co	Ni	Al	As	Cd	Cu
AFWTF-2001(Active)	**33.32** (10.77)	**29.60** (5.51)	**28.66** (1.58)	-	-	**0.28** (0.13)	**30.48** (3.63)
AFWTF-2004(Non-active)	**8.14** (3.15)	**10.61** (4.21)	**3.43** (2.13)	**1543** (67.7)	**0.61** (0.46)	**0.15** (0.15)	**17.42** (1.83)
Gu‡nica-2001	**5.58** (1.90)	**4.19** (0.06)	**14.64** (4.75)	-	-	**0.28** (0.01)	**15.39** (4.16)
Gu‡nica-2003‡2004	**2.33** (2.24)	**1.82** (0.43)	**3.75** (1.85)	**341.2** (112.9)	**1.04** (0.25)	**0.28** (0.22)	**12.16** (2.83)



ZONA CIVIL

VIEQUES, Puerto Rico



Plomo (µg/g peso seco)

70
6
5
4
3
2
1
0

ROLES

C.
A. fa
U.
C.
U.
C.
A. fa
U.
C.
A. fa
U.

Polígono de Bombardeo

MC/ C. García

MC Finca

Finca Bo. Monte Santo

ZONA CIVIL

Pigeon Peas

Leaf samples (June 2000)

	Cu	Mn	Zn	Pb	Ni	Cd	Co
Monte Carmelo/Vieques	18.30	182.99	34.77	10.98	10.37	2.44	14.64
	12.58	203.73	27.56	10.19	10.19	3.00	14.98
average	**15.44**	**193.36**	**31.17**	**10.59**	**10.28**	**2.72**	**14.81**
std dev	(4.04)	(14.67)	(5.10)	(0.56)	(0.13)	(0.40)	(0.24)
Sector Gobeo/Vieques	28.87	77.63	87.57	54.43	7.10	0.95	7.10
	22.75	71.56	71.56	43.85	6.20	1.24	4.96
average	**25.81**	**74.60**	**79.57**	**49.14**	**6.65**	**1.10**	**6.03**
std dev	(4.33)	(4.29)	(11.32)	(7.48)	(0.64)	(0.21)	(1.51)
CONTROL	10.45	142.98	31.62	4.95	7.97	0.82	4.40
Cerro Las	11.33	132.69	29.58	4.98	7.46	0.83	3.87
Mesas/Mayagüez	11.08	130.69	30.4	4.55	7.67	0.85	4.55
	11.30	143.36	31.98	5.24	6.66	1.10	4.41
promedio	**11.04**	**137.43**	**30.90**	**4.93**	**7.44**	**0.90**	**4.31**
std dev	(0.41)	(6.68)	(1.11)	(0.28)	(0.56)	(0.13)	(0.30)
MC VIEQ/CONTROL	**1.4**	**1.4**	**1.0**	**2.1**	**1.4**	**3.0**	**3.4**
SG VIEQ/CONTROL	**2.3**	**0.5**	**2.6**	**10.0**	**0.9**	**1.2**	**1.4**


Monte Carmelo
Vieques, Puerto Rico
Pigeon Peas
(fruit & leaf samples)
August, 2001

Monte Carmelo, Vieques (Puerto Rico)

Pigeon Peas

	Cu	Zn	Ni	Pb	Cd	Co
Leaf samples	15.00	39.15	2.45	14.70	2.58	16.78
	6.43	25.08	2.06	15.53	2.26	18.13
average	**10.72**	**32.12**	**2.26**	**15.12**	**2.42**	**17.46**
std dev	(6.06)	(9.95)	(0.28)	(0.59)	(0.23)	(0.95)
Fruit samples	7.02	35.31	5.33	7.80	2.21	23.29
	9.41	32.68	4.27	4.89	4.13	28.21
average	**8.22**	**34.00**	**4.80**	**6.35**	**3.17**	**25.75**
std dev	(1.69)	(1.86)	(0.75)	(2.06)	(1.36)	(3.48)
FRUIT/LEAF	**0.8**	**1.1**	**2.1**	**0.4**	**1.3**	**1.5**

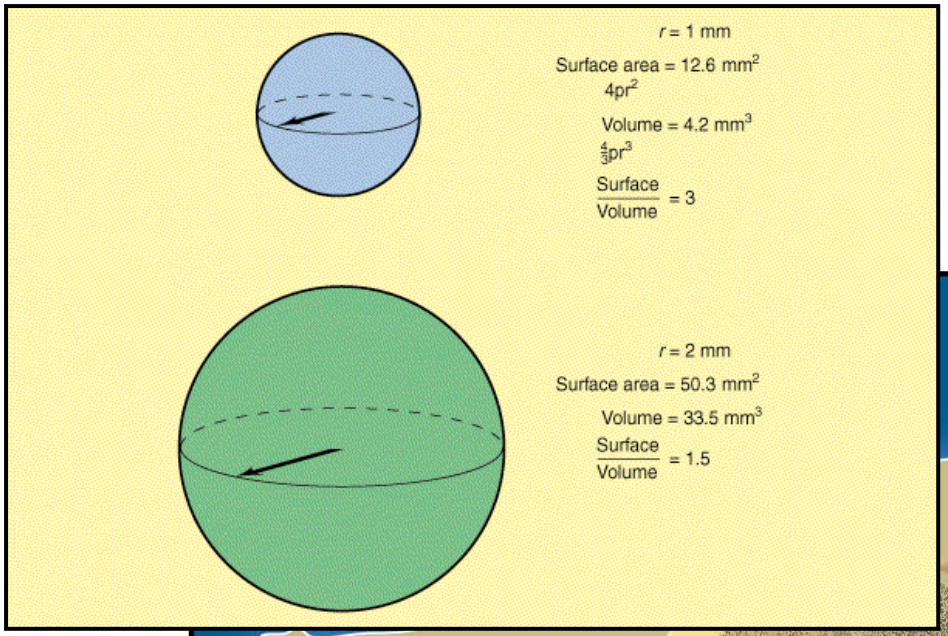
August 2001

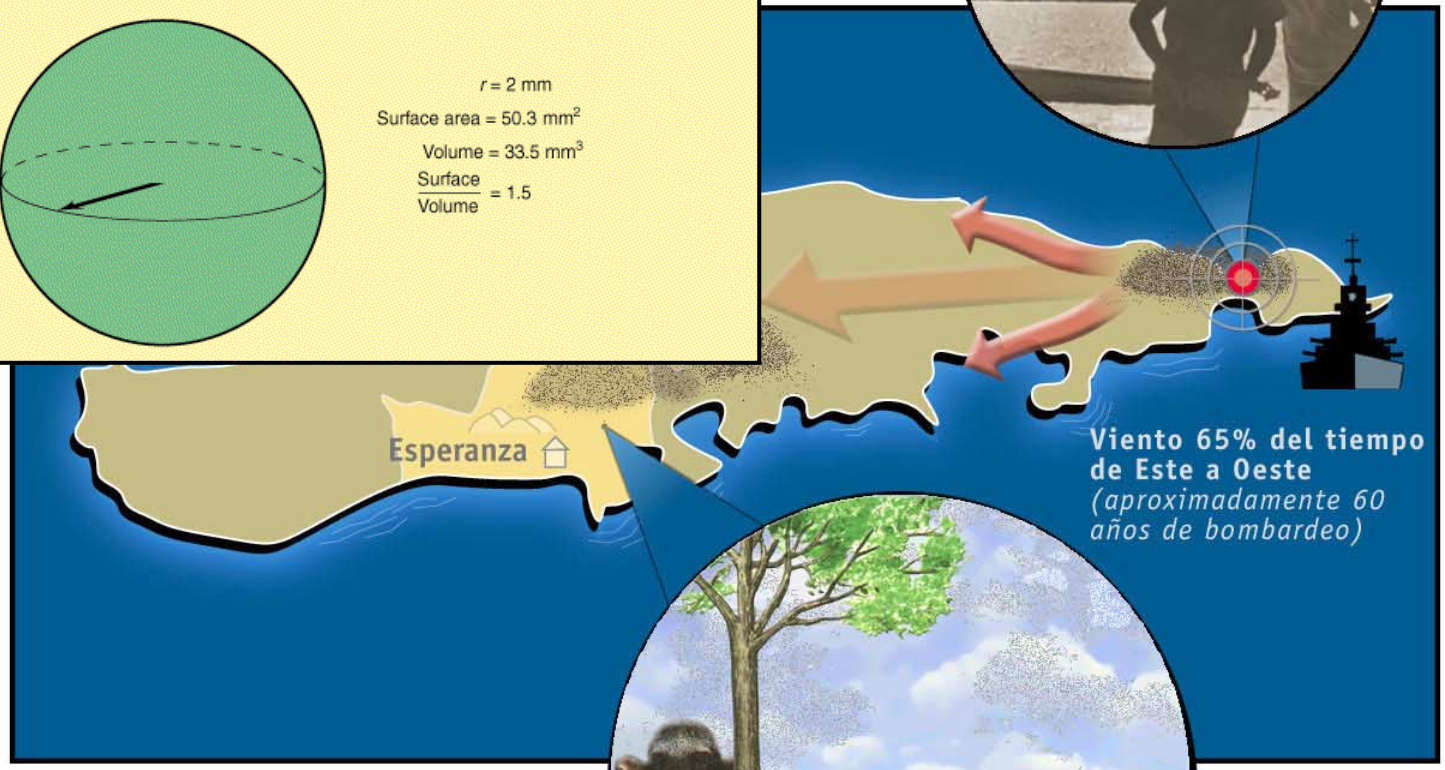
2ND Draft
Preliminary Evaluation of Health Risks Related to Naval Activities at the Atlantic Fleet Weapons Training Facility on Vieques, Puerto Rico

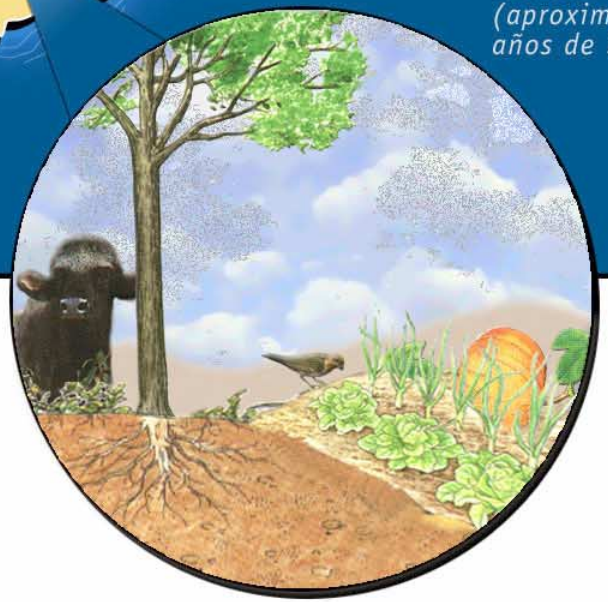
August 2000

"Bombing activities that occur on the eastern portion of the island are likely to produce airborne emissions that would be carried in a westerly direction." US Navy


20,000 - 30,000 explosion every year!
> 50 years!







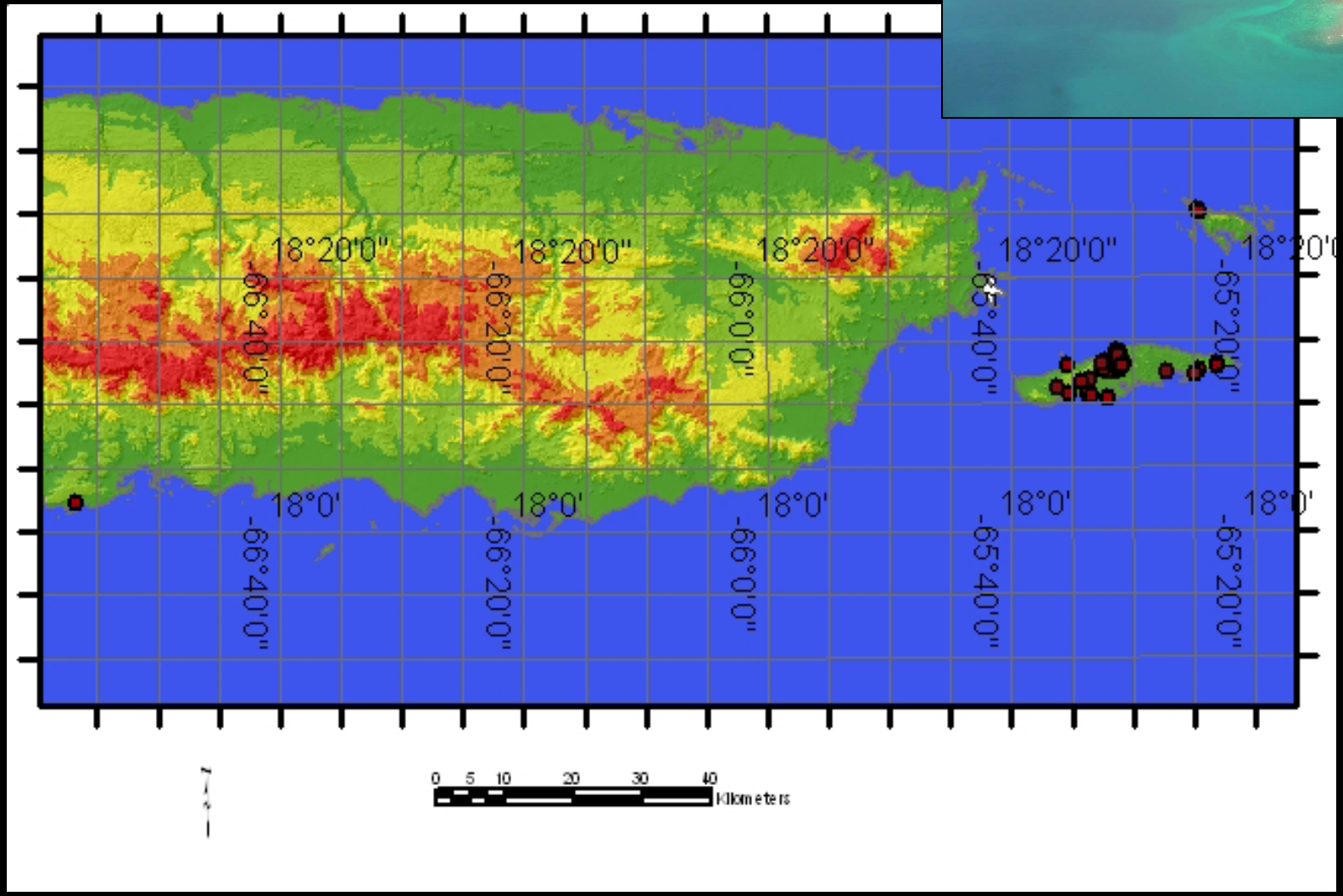
Acumulación a niveles tóxicos de plomo, cadmio, manganeso, cobalto, níquel y cobre.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Vieques / 2003-05

Departamento de Salud de PR



Caribbean Journal of Science, Vol. 39, No. 2, 000–000, 2003

Trace Element Composition in Forage Samples from a Military Target Range, Three Agricultural Areas, and One Natural Area in Puerto Rico

ELBA DÍAZ AND ARTURO MASSOL-DEYA

Department of Biology, University of Puerto Rico, Mayagüez, Puerto Rico 00681 amassol@stahl.uprm.edu

ABSTRACT
scarce. Trace
Facilities (A
State Forest.
with acid. C
Rico. Simila
Sporobolus a
and marine

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Estudio de la vegetación como bioindicador (Centinela) de disturbios Ambientales y riesgos a la salud de los residentes de la isla municipio de Vieques, Puerto Rico

Laboratorio de Microbiología Ambiental
UPR- Mayaguez

Debido a la conocida capacidad de las plantas para acumular contaminantes del suelo, agua o aire, la vegetación es un buen indicador de disturbios ambientales. Este estudio ampliará trabajos realizados en nuestro Laboratorio de Ecología Tropical en la Universidad de Puerto Rico - Mayagüez (UPRM) junto a la organización de autogestión comunitaria Casa Pueblo de Adjuntas para analizar la vegetación de consumo agrícola y otras especies como indicadores de contaminantes ambientales (ej. plomo, cadmio, uranio, entre otros) y su riesgo a la salud de los residentes de la isla municipio de Vieques.

Universidad de Puerto Rico
Recinto de Mayagüez

Estudio de la vegetación como bioindicador (Centinela) de disturbios Ambientales y riesgos a la salud de los residentes de la isla municipio de Vieques, Puerto Rico

Laboratorio de Microbiología Ambiental
UPR- Mayaguez

Regresar a la página principal

- Descripción del proyecto
- Antecedentes
- Toxicología de metales pesados
- ¿Por qué vegetación como bioindicador?
- Objetivos específicos
- Metodología
- Lista de abreviaturas
- Resultados
- Actividades realizadas
- Recomendaciones
- Galería
- Publicaciones
- Agradecimientos

Publicaciones

Ciencia y Ecología: Vieques en Crisis Ambiental. Publicaciones Casa Pueblo, Tercera Edición 2002, 85 pp.

Massol-Deyá, A. and E. Díaz. 2003. Trace elements composition in forage samples from various anthropogenically impacted areas in Puerto Rico. Caribbean Journal of Science. 39:215–220.

Massol, A., D. Pérez, E. Pérez, M. Berrios, and E. Díaz. 2005. Trace elements analysis in forage samples from a US Navy bombing range (Vieques, Puerto Rico). Int. J. Environ. Res. Public Health, Vol 2 (1-2).

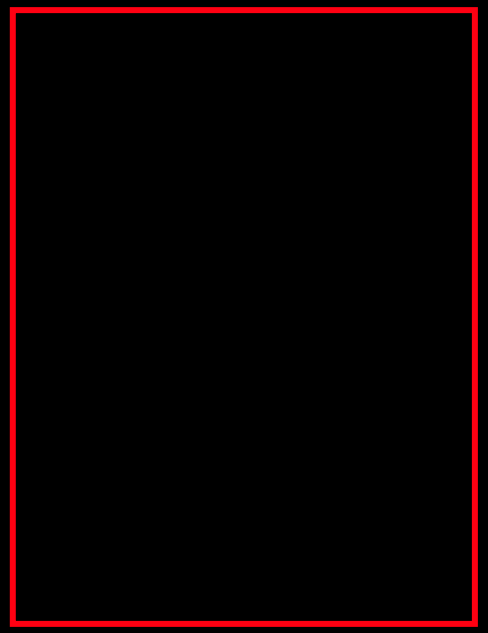
Biorremediación: de una realidad social a una solución ecológica. Publicaciones Casa Pueblo, Segunda Edición 2000, 65 pp.

Otros documentos:

García, C. UPR-Humacao. "Praderas de Hierbas Marinas". Un resumen general sobre la biología y ecología de las hierbas marinas en Puerto Rico. http://cuhwww.upr.clu.edu/~cgarcia/ecologiacostanera/Clase/Tha001/THALASIA.98.htm

Agradecimientos

» Elba Díaz
» Dustin Pérez
» Ernie Pérez
» Manuel Berríos



- Botánicos [UPR-Mayagüez]
- Familia Zenón-Encarnación
- Programa de Biotecnología Industrial, UPRM
- Casa Pueblo, Adjuntas
- Departamento de Salud de PR
- Escuela Elemental Playa Grande, Victor Belardo y los estudiantes de programa ambiental