Research and Policy Implications of Material Flows

Presentation at the International Sustainability Workshop:

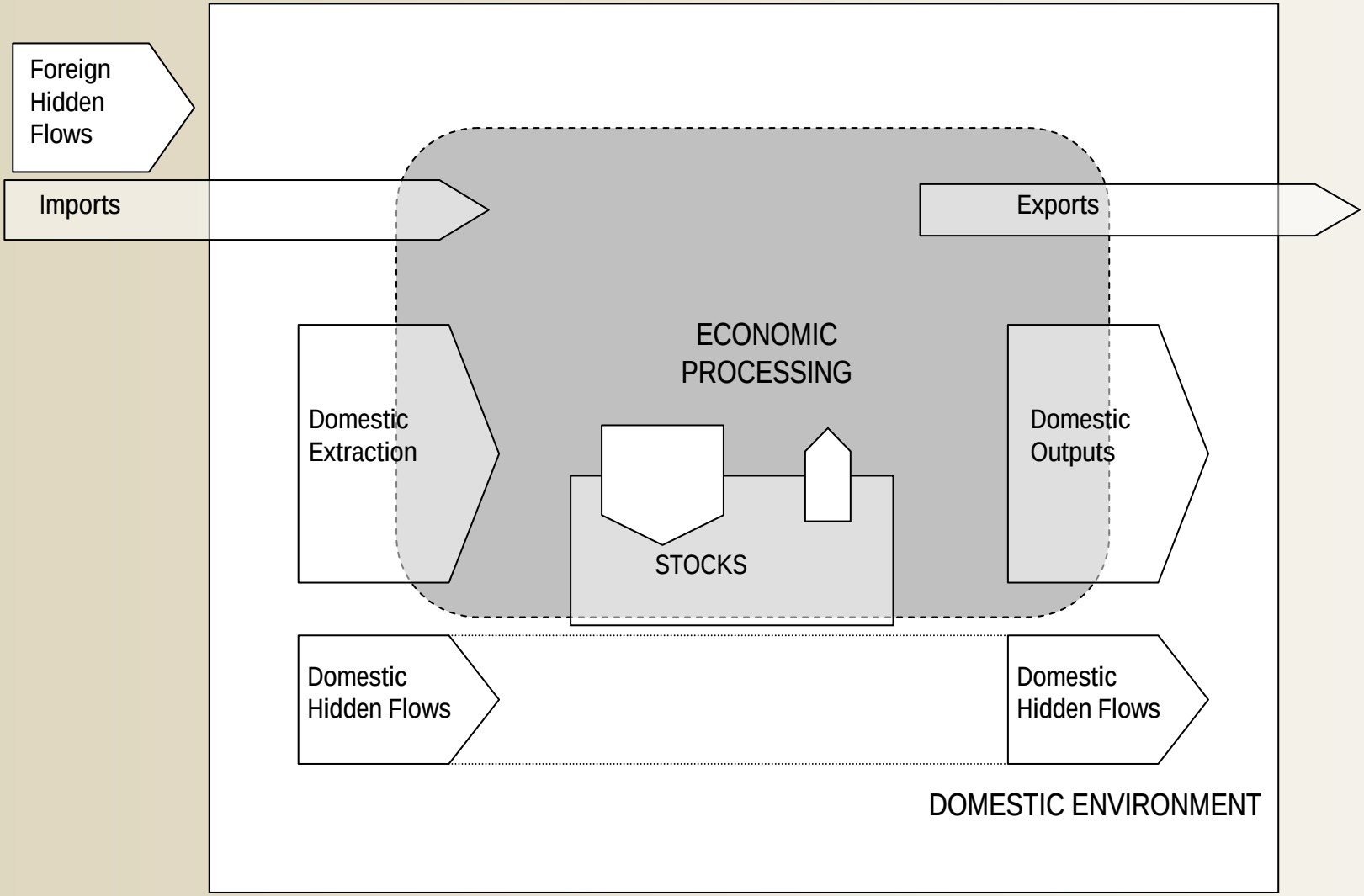
May 18-20, 2005, Washington, DC

Donald G. Rogich
Consultant to World Resources Institute
floman@erols.com

Categories of Material Flow Studies

- Substance Flow studies
- Life Cycle Analyses
- National Material Flow Accounts

The Materials Cycle



D. Rogich, 2005

Partial List of MFA Milestones

- 1997 Resource Flows -Inputs (WRI et al)
- 2000 Weight of Nations-Outputs (WRI et al)
- 2002 EU Indicators and Analysis (Eurostat)
- 2004 National Academy Report
- 2004 US MFA study (WRI)
- Individual country studies
- 2004-5 OECD meetings

Current U.S. MFA

- Current WRI study represents an expansion and extension of previous work
- Consists of about 160 discrete commodity **inputs**
- Disaggregated by **use** to produce about 630 discrete **outputs** to the environment, or addition to stock. characterized by **M,Q,V**
- Time period 1975-2000
- Flows can be analyzed individually, or in combinations, or aggregated to produce national indicators
- Publication and web database expected

Material Flows Included

Minerals and metals

Abrasives (Manufactured)
Aluminum
Antimony
Antimony
Arsenic
Asbestos
Asphalt & Road Oil
Ball Clay (Clay)
Barite
Bentonite (Clay)
Beryllium
Bismuth
Boron
Bromine
Cadmium
Caustic soda
Cement
Cesium
Chlorine
Chromium
Clay
Cobalt
Columbium (Niobium)
Common Clay
Copper
Crushed stone
Diamonds (Industrial)
Diatomite
Feldspar
Fire Clay
Fluorspar
Fuller's Earth (Clay)
Gallium
Garnet (Industrial)
Germanium
Gold
Graphite, natural
Gypsum
Helium
Indium
Iodine
Iron and Steel
Iron and Steel Slag
Iron ore
Kaolin (Clay)
Kyanite
Lead
Lime
Lithium
Magnesium compounds
Magnesium metal
Manganese
Mercury
Mica (natural), scrap and flake
Mica (natural), sheet
Molybdenum
Nickel
Nitrogen
Peat
Perlite
Phosphate rock
Phosphoric acid
Potash
Pumice & Pumicite
Quartz crystal (Industrial)
Rare earths
Rhenium
Rubidium
Salt
Sand & gravel construction
Sand and gravel Industrial
Scandium
Selenium
Silver
Silicon
Stone, dimension
Strontium
Sulfur
Talc & Pyrophyllite
Tantalum
Tellurium
Thallium
Thorium
Tin
Tungsten
Vanadium
Vermiculite
Yttrium
Zinc
Zirconium and Hafnium

Non-renewable organic

Benzene
Butadiene (1,3-)
Butane
Butylene
Coal
Coal Combustion products
Coke
Crude Oil
Distillate Fuel Oil
Ethane
Ethylene
Jet Fuel (incl. av. gas)
Kerosene
Lubricants
Motor Gasoline
Naphtha
Natural gas (Methane)
Pentanes Plus
Petroleum Coke
Propane
Propylene
Residual Fuel Oil
Toluene
Xylene

Priority chemicals

Aldrin
Benzo(g,h,I)perylene
Chlordane
Hexachlorobenzene
Heptachlor
Isodrin
Methoxychlor
Octachlorstyrene
PCB's
Pendimethalin
Pentachlorobenzene
Tetrabromobisphenol
Toxaphene
Trifluralin

Renewable organic

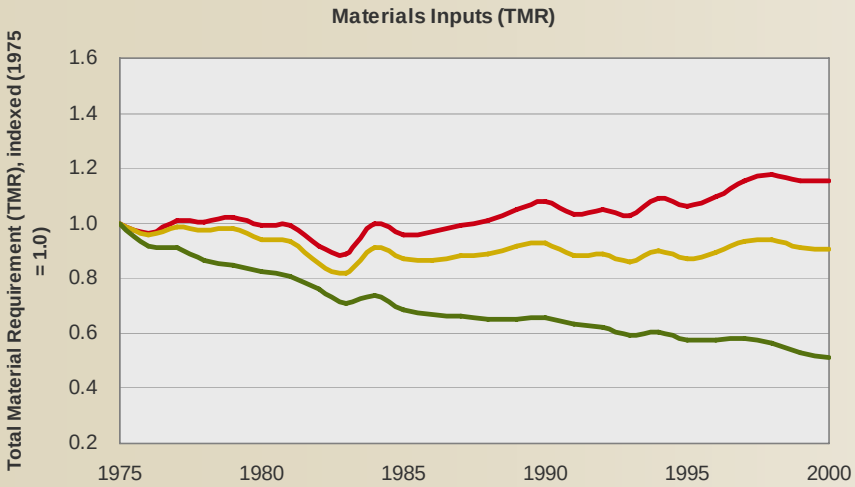
Animal by-products
barley
Beans, dry edible
Beef and Veal
Cattle (live)
Cattle (slaughtered)
Chicken meat
Chickens
Chickens (live)
Citrus Fruits
Commercial Vegetables
Corn
cotton
cottonseed
Eggs
Ethanol
Fish
Fuelwood
Hay
Industrial Roundwood
Lumber
Manure
Milk & Milk Products
Millet
Mushrooms
Mutton
Nickel
Non-citrus Fruits
Oats
Other Industrial
Roundwood
Paper & Board
Peanuts
Pigs
Pigs (live)
Plywood & Laminated Veneer
Lumber (LVL)
Pork
Potatoes
Pulpwood
Rice
Rye
Sand and gravel Industrial
Sheep (live)
Sheep (slaughtered)
sorghum
Soybeans
Sugar Beets
Sugar Cane
Sunflower Seeds
Tobacco
Tree Nuts
Turkey (meat)
Turkeys (live)
Turkeys (slaughtered)
Wheat
Wood Panels
Woodpulp
Wool
Yard Trimmings

Infrastructure

Construction earth moving
Dredging
Erosion
Highway earth moving
Water

World Resources Institute, 2004

Trends in U.S. Material Flows, 1975-2000



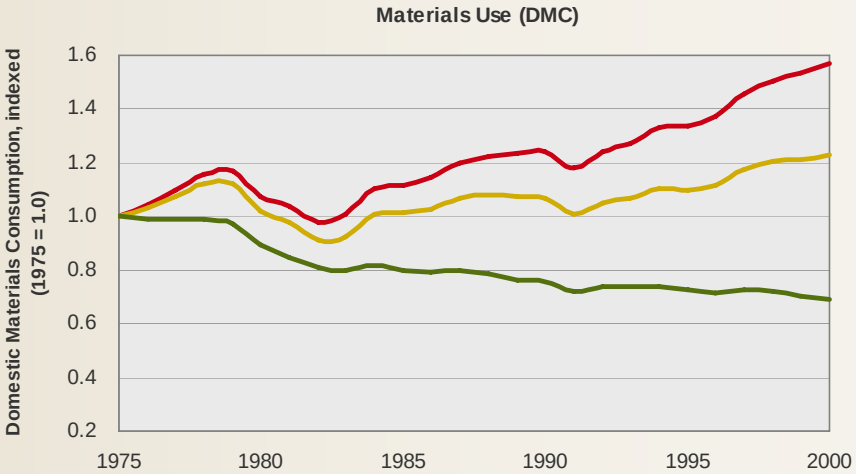
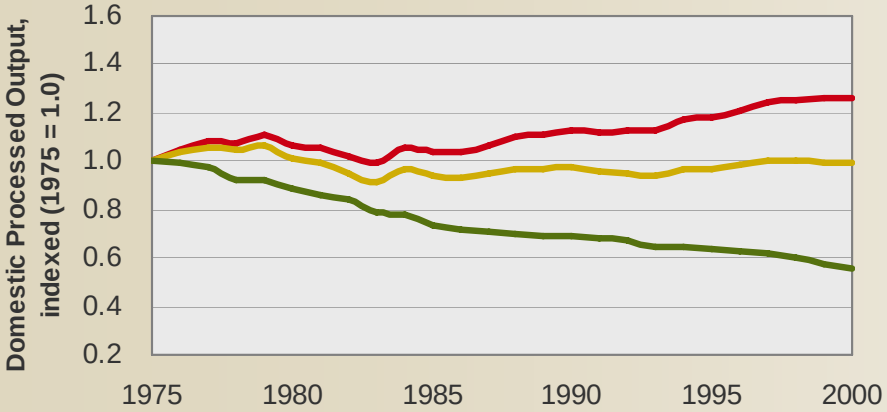


Figure 4: Materials Outputs (DPO)



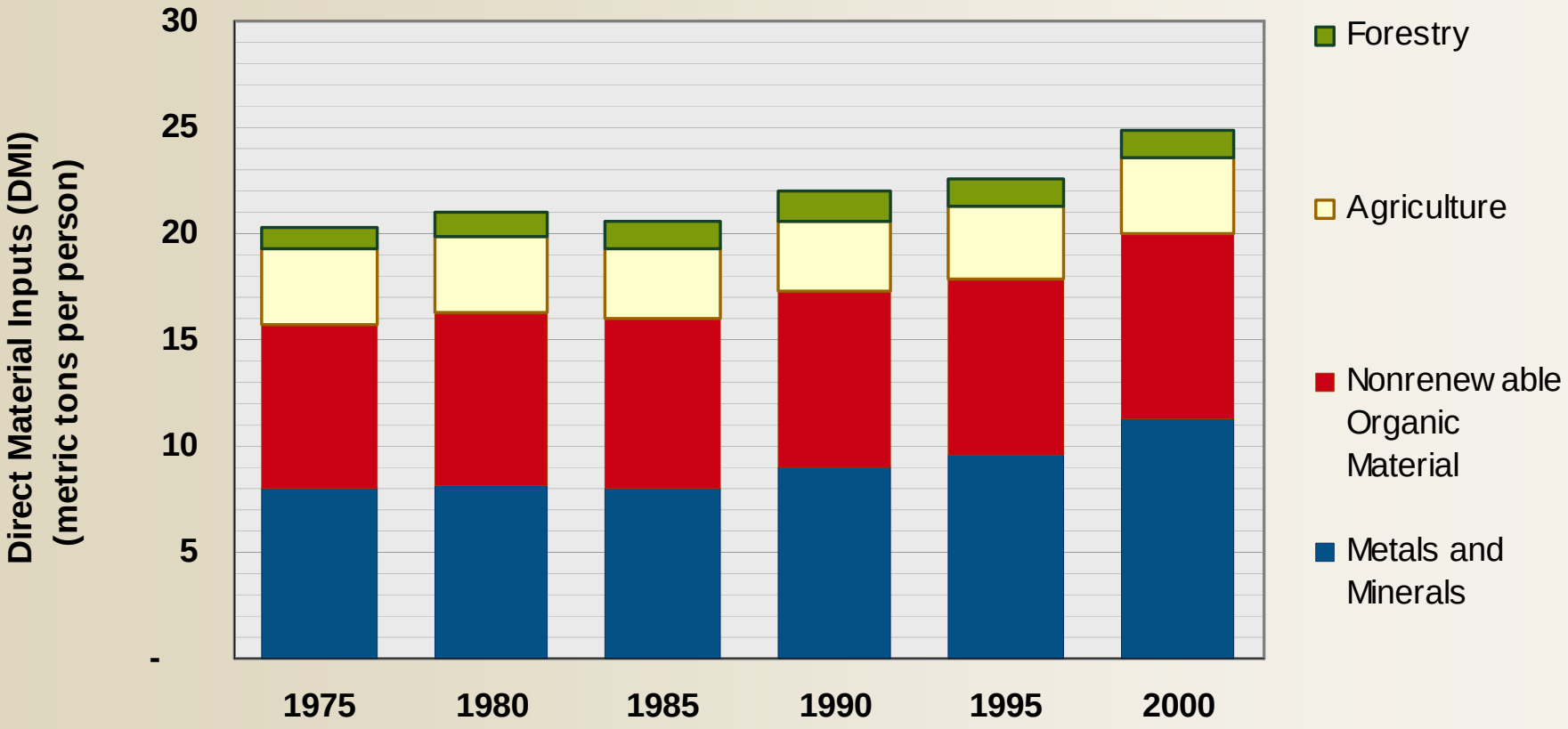
Total

Per Capita

Per GDP (constant $US)

World Resources Institute, 2004

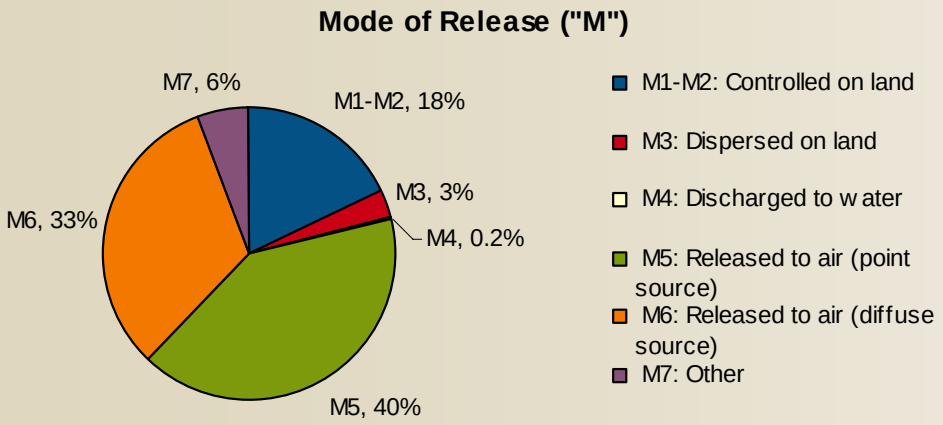
Materials Use Per Capita, 1975-2000

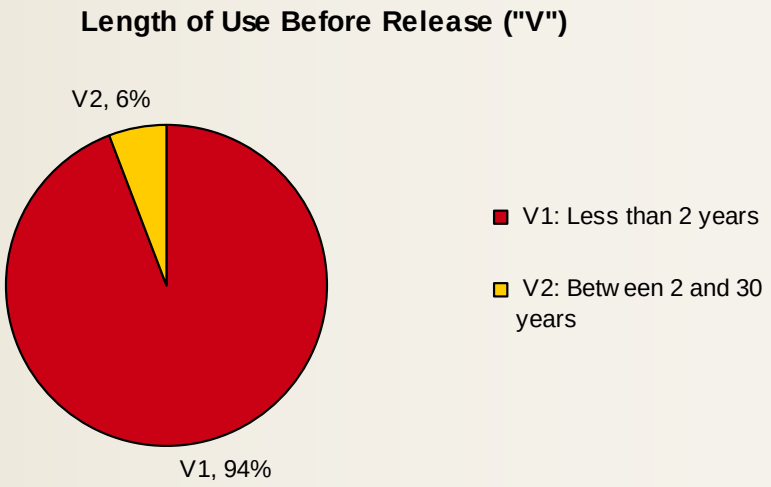


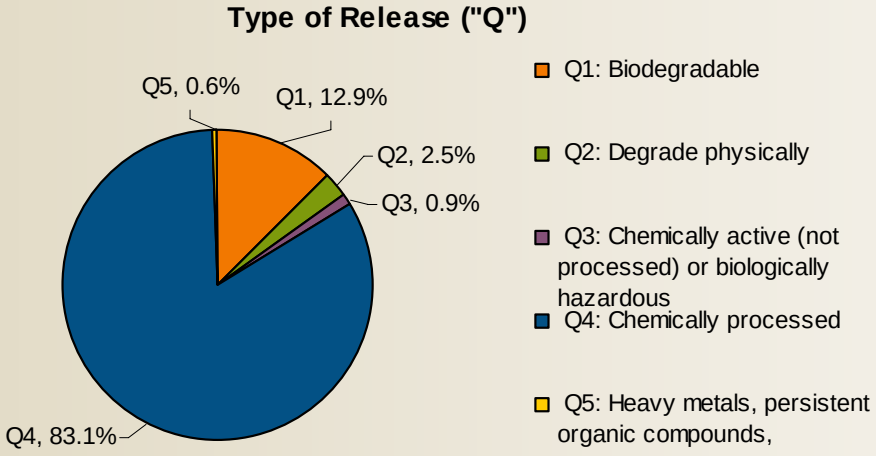
Source: WRI Material Flows Database, 2005.

World Resources Institute, 2004

Characterization of Material Outputs to the Environment, 2000

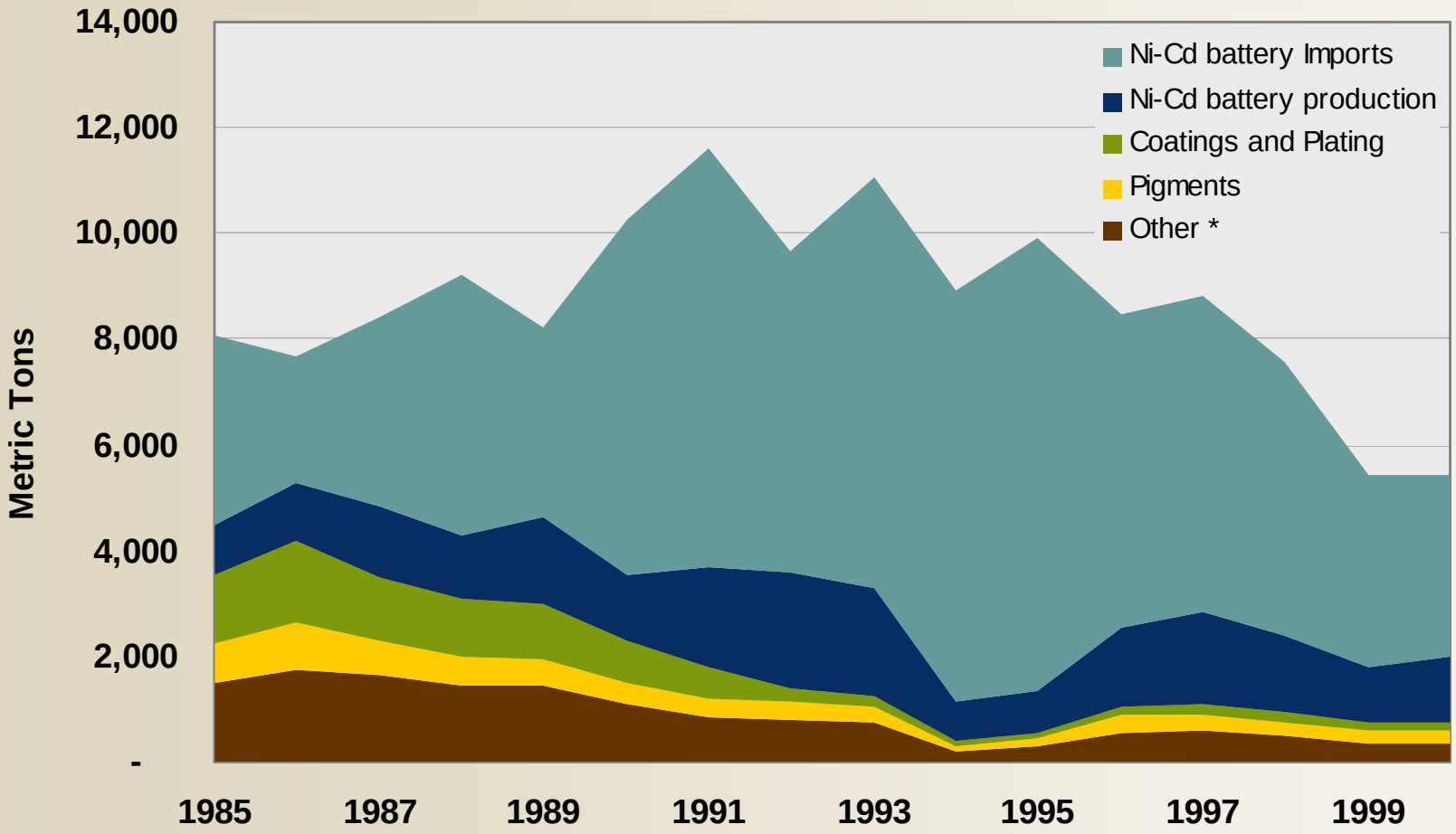






World Resources Institute, 2004

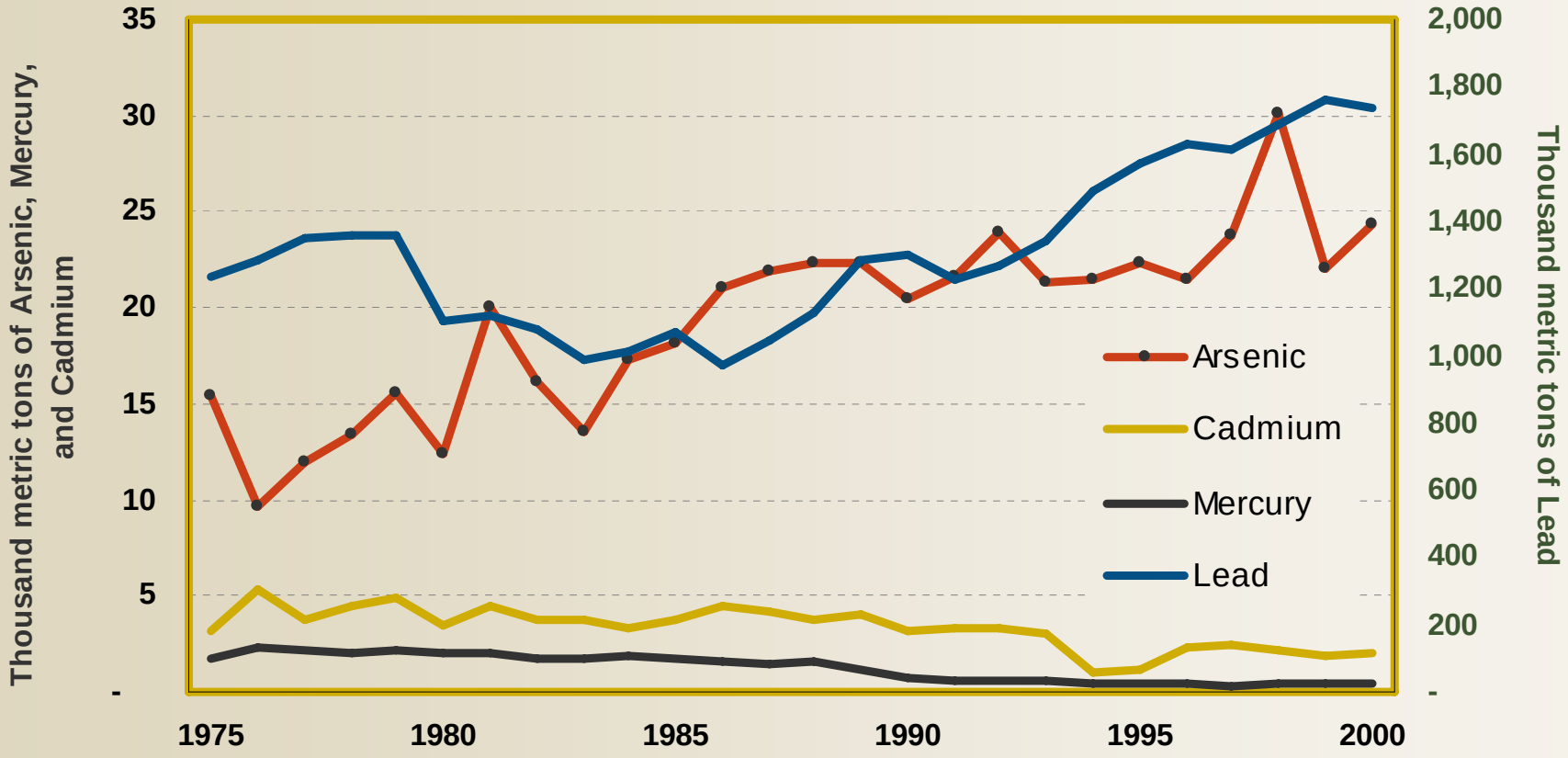
Cadmium Uses 1975-2000



Note: "Other" releases of Cadmium are from plastic stabilizers, coal combustion emissions, and alloys.

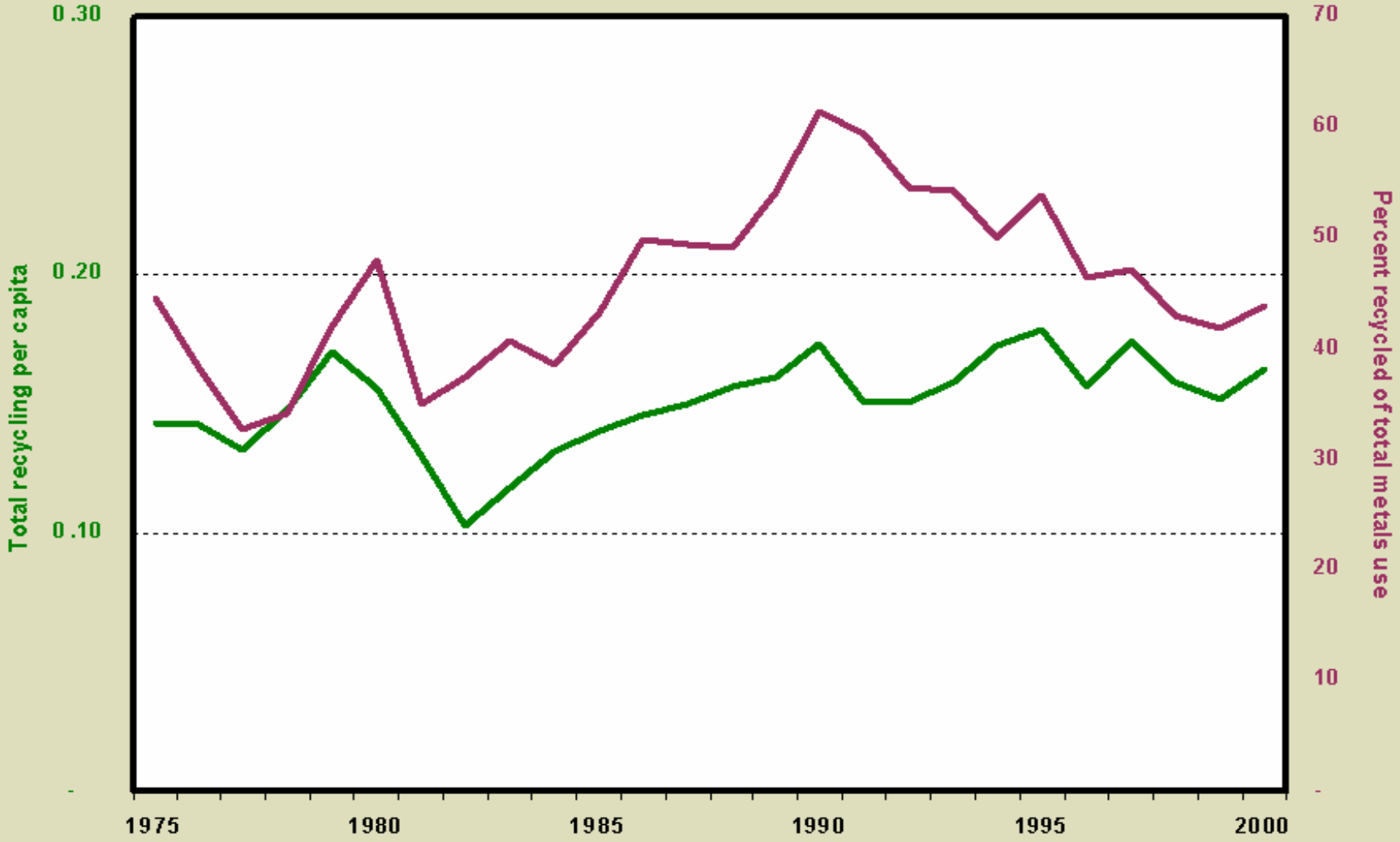
World Resources Institute, 2004

Heavy Metals Use



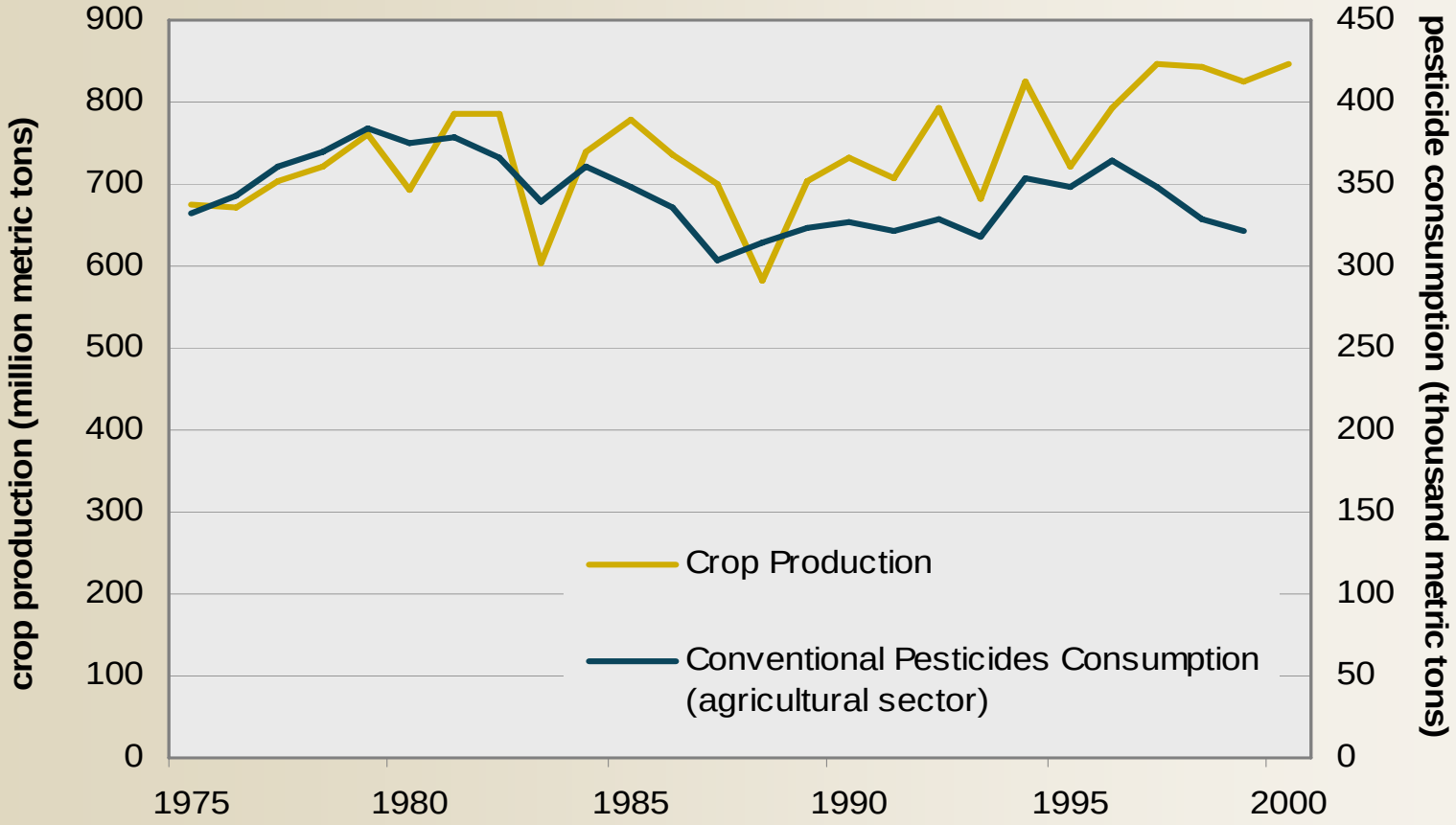
World Resources Institute, 2004

Metals Recycling Per Capita and as a Percent of Total Use



World Resources Institute, 2004

Crop Production and Pesticide Consumption



World Resources Institute, 2004

Housing and Construction Materials in the United States

Material	Used for:	Consumption in 2000 (000 metric tons)	% change since 1975
Asbestos	Roofing products	9	-72%
Aluminum	Construction	1,113	27%
Gypsum	Gypsum products	27,400	201%
Clay, ball	Floor and wall tiles	331	373%
Clay, ball	Sanitary ware	274	372%
Titanium dioxide	Paint, varnishes and lacquers	575	93%
Lumber	Construction	68,227	76%
Plywood & Laminated Veneer Lumber (LVL)	Construction	9,010	19%
Wood Panels	Construction (estimated 80%)	13,942	133%
Lumber	Other	10,698	53%
Plywood & Laminated Veneer Lumber (LVL)	Other	3,897	128%
Wood Panels	Other (estimated 20%)	3,486	133%
TOTAL		**138,962**	**91%**
Total population (millions)		**275.3**	**28%**
Total housing units (thousands)		**115,905**	**46%**

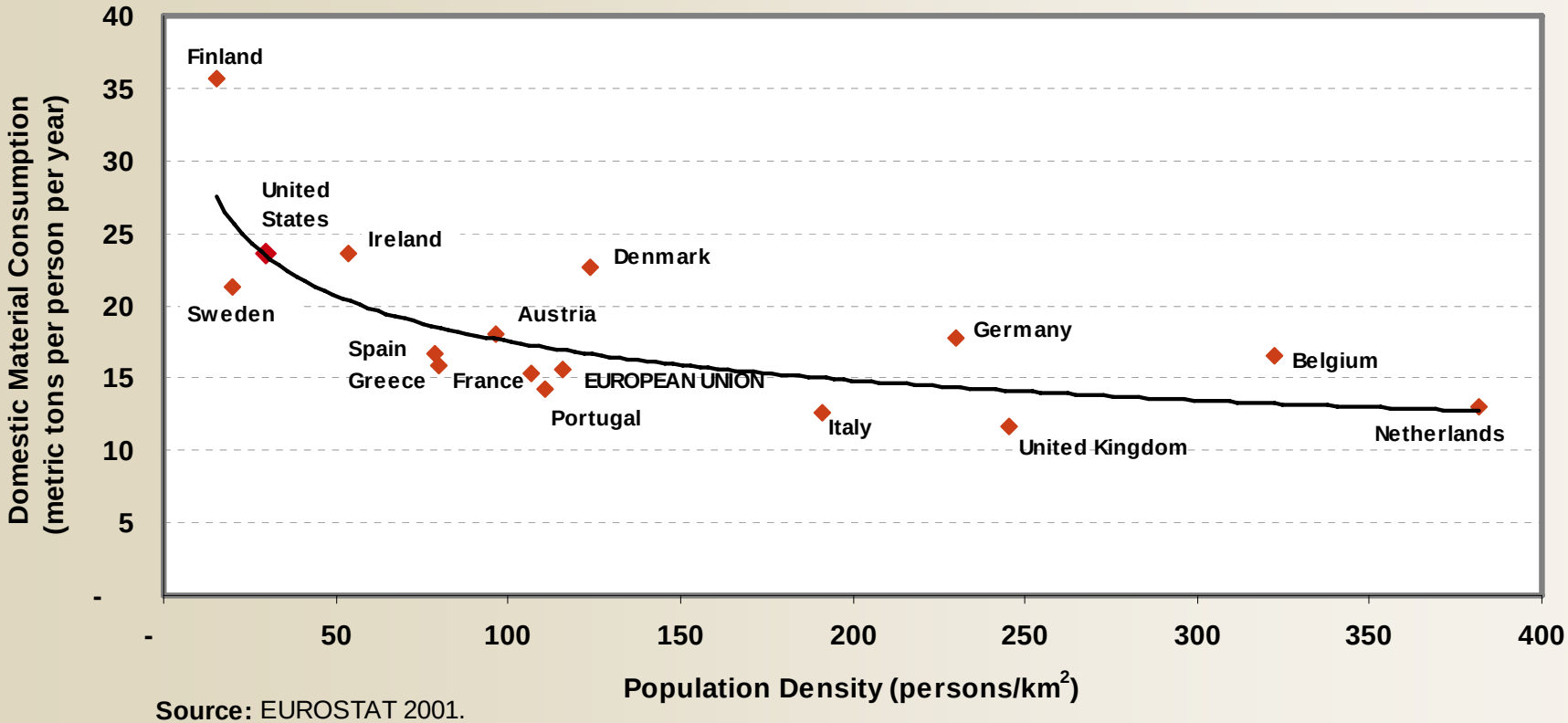
World Resources Institute, 2004

Net Imports of Finished Goods in 2000

- Autos- about 2 million tons of metal, plastic and other materials. Most metal probably recycles.
- Clothing-about $50 billion, or 2.5 million tons of material. Little recycling or reuse?
- Toys-about $9.5 billion of mostly plastic and metal materials. About 60% of value is material cost
- Televisions-about $40 billion of mostly plastic, metal and some hazardous material

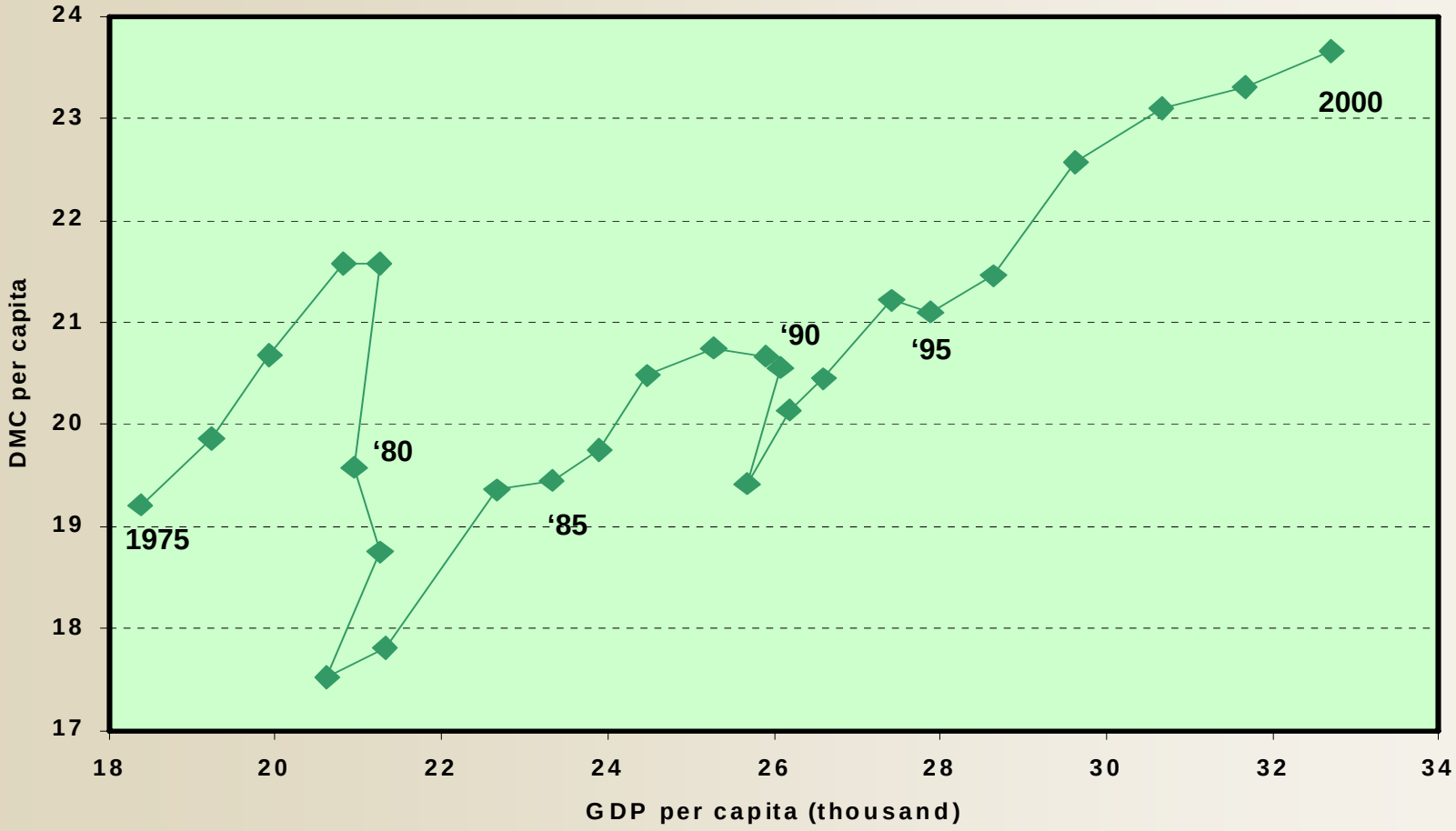
D. Rogich, 2005

Correlation of Population Density with DMC Per Capita in the United States and Europe, 2000



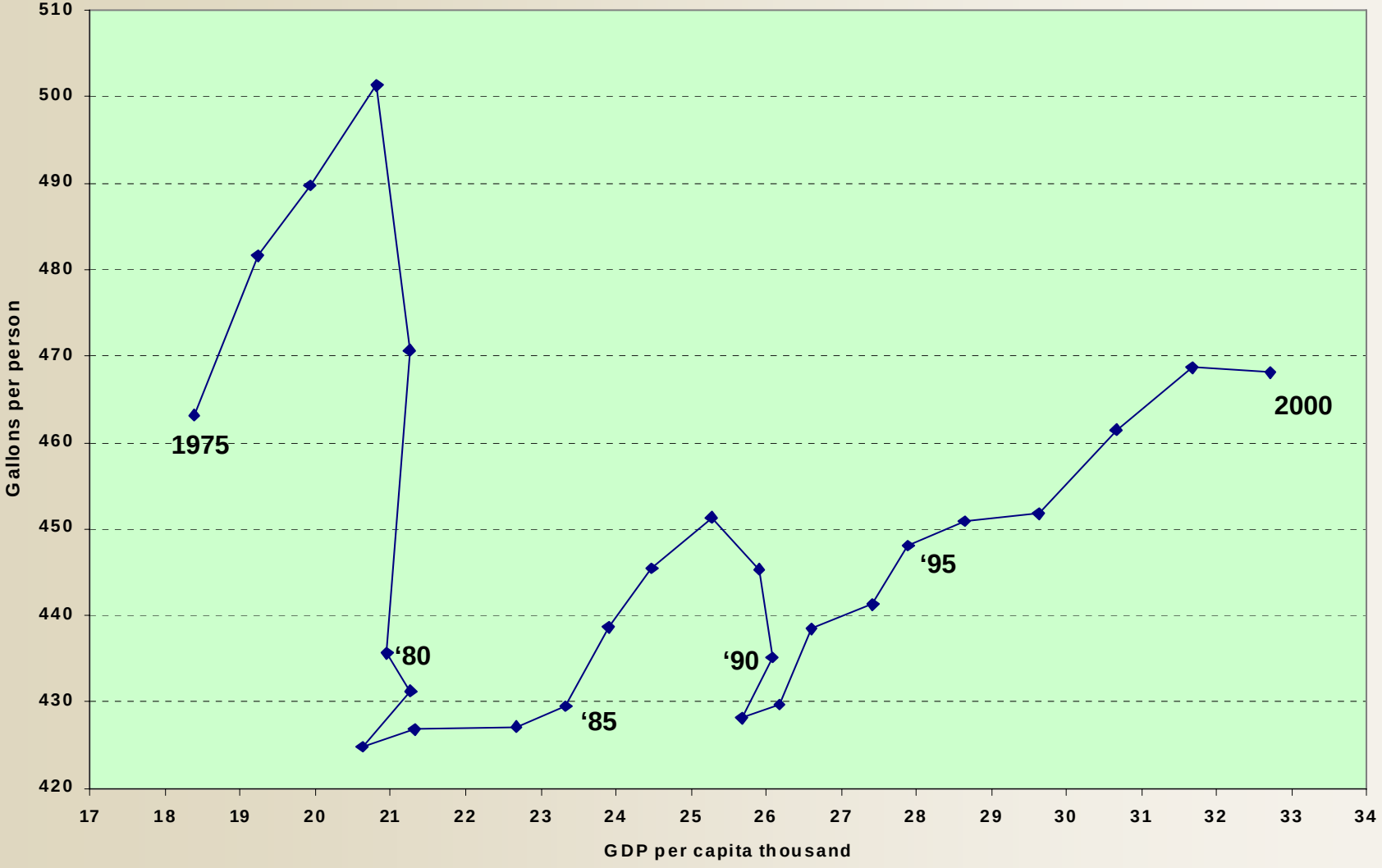
Source: EUROSTAT 2001.

DMC Per Capita vs. GDP Per Capita, 1975-2000



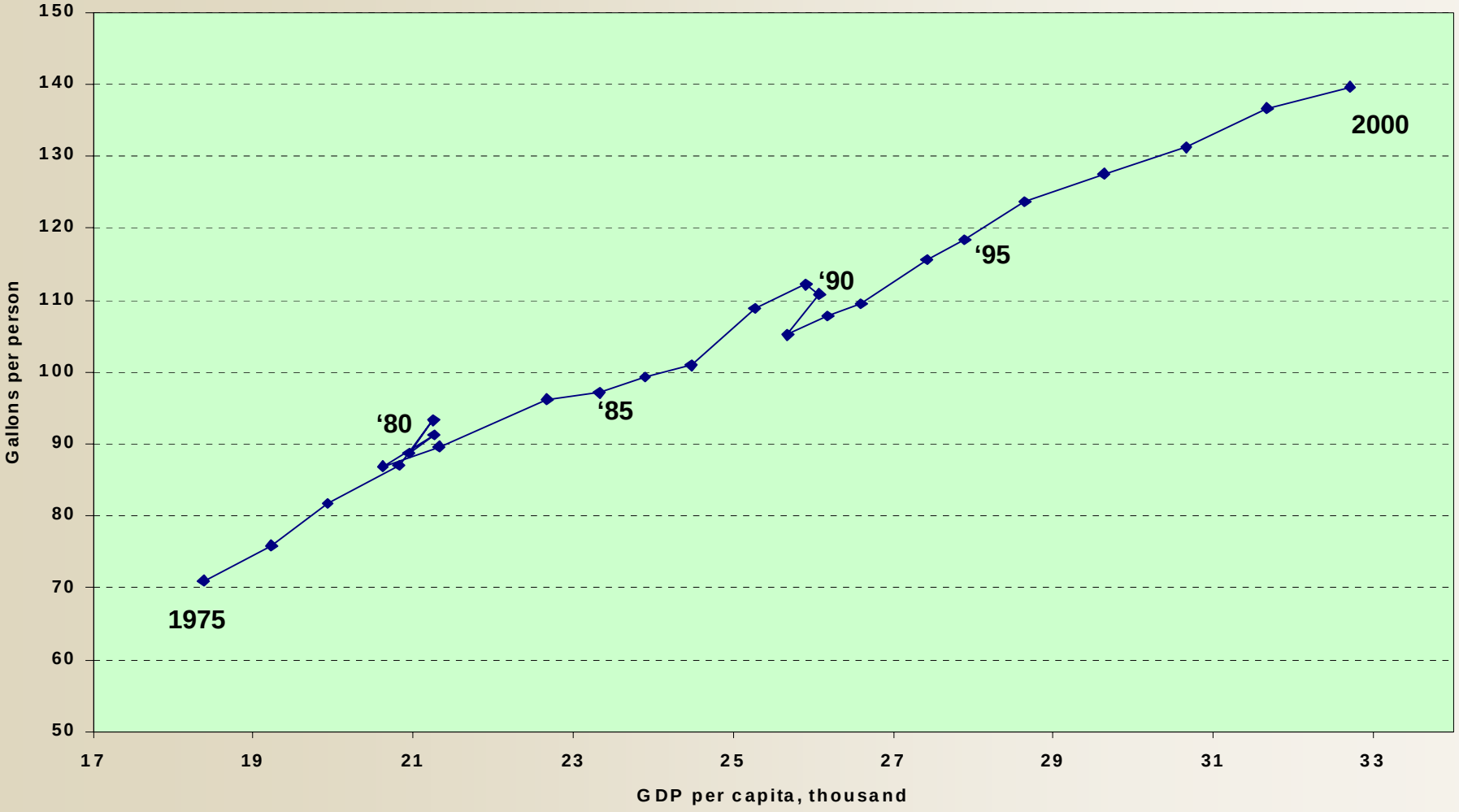
D. Rogich, 2005

Gasoline Consumption Per Capita vs. GDP Per Capita, 1975-2000



D. Rogich, 2005

Diesel Fuel Consumption Per Capita vs. GDP Per Capita



D. Rogich, 2005

Current Status

- The methodology for producing national DMC and DMI **input** indicators appears to be fairly standardized between countries
- Indicators of **outputs, additions to stock and hidden flows** not as well developed
- Accounts require improvements in data and analytic techniques
- MFA currently have no institutional home or continuous funding mechanism

Research and Technical Issues

- Direct correlation with impacts
- Improved data (chemicals and priority substances)
- Import and export of finished goods
- Relation to economic accounts-sector studies
- Regional and local studies
- Time phasing of inputs, outputs and recycling
- Consideration of water and air
- Identify critical flows in relation to GDP growth
- Improved estimates of hidden flows and movements of earth

Institutional Issues

- Where will the R&D be done? Potentially a significant role for the academic community (economic sector and regional specialization)
- Implementation in the federal government (Is there a product champion-pull or push?)
- Need to increase involvement with business and environmental community
- Mechanism for continuing interaction with global community

Conclusions

- The creation of comprehensive and detailed MFA is possible and practical.
- MFA are an important step towards evaluating the environmental consequences of economic growth.
- MFA can help prioritize the most critical flows with respect to sustainability.
- Institutionalization and additional research and development are required to create a mature system of MFA in the US.
- Continuously increasing material inputs and outputs are not compatible with sustainability.