Scientific Publication Information Retrieval & Evaluation System (SPIRES)

Linking NLM PubMed Data to NIH Extramural Grant Data

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NIH OD OER ORIS - eRA Project
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What is SPIRES?

- A “translation” of NLM publication data into a relational database that can be linked *directly* to eRA grant data.
- Oracle Text word indexes of various publication and project data elements.
- Third party journal impact factor data and (in the future) citation information.
- SPIRES application provides tools for analysis of publication and project data.
- SPIRES database also serves as a data provider to other NIH systems.

What is SPIRES?

How SPIRES Searches PubMed for NIH Publications

- SPIRES extracts all publications from PubMed that meet these search criteria:
  - Where the publication year is >= 1995.
  - Where the GRANT tag in the citation contains data AND
  - Where the GRANT *string* contains an NIH organization code (2 letter phs_org_code or full abbreviation [ie-CA or NCI])

SPIRES Database Limitations

- Not all publications related to a grant are necessarily cited in PubMed. For example, a grant that is part of a Center may cite the publication whereas the center grant may not.
- Not all journals in which grantees publish are cited in PubMed.
- Not all journals allow the author to acknowledge grant support.

SPIRES History

- Project originated at NIEHS in 2001 by Dr. Ben Van Houten of DERT.
- Primary goal was to reliably match scientific publications from PubMed with their corresponding NIH extramural grant numbers, for purposes of program analysis.
- Version 1 of SPIRES completed in Spring 2002 by Paul Jordan and Ying Gao at NIEHS.
- Included data from 1995 to Present for NIEHS, NICHD, NIA and FIC.
- Data was downloaded and updated MANUALLY each month.

Goals for NIH SPIRES Project

NIH SPIRES initial development funded by a grant from NIEHS director in fall 2005.
Development started in December 2005

- Expand database to include all NIH ICs.
- Further refine/improve grant number matching process.
- Improve data query and presentation tools.
- *Major Goal:* Create an *automated* process that updates the publication database daily and reliably.

NIH SPIRES: Database Snapshot

(Database statistics as of November 25, 2007)

- 24 NIH ICs represented
- Publication data for 1995 – Present
- 716,487 Total Publications
- 1,609,318 Project to Pub Matches
- Approx. 5000 Journals
- ISI Journal impact factor data for 1997 – 2005 publication years

Why is SPIRES Different from Other Publication Search Tools?

- SPIRES query tool provides a TWO WAY search option, *in one system:*
  - Query publication data and view all related project data from eRA tables.
  - Query eRA project data and view all related publication data.

SPIRES Application Features

- Query publication data and view all related project data from eRA tables, including project history.
- Query eRA project data and view all related NLM publication data.
- Perform Oracle Text searches on publication and project data elements.
- Generate a variety of standard and custom reports.

IC's w/Pubs, Represented in SPIRES

Included in initial data load and daily update

CSR	**NIA**	**NIDCR**
FIC	**NIAAA**	**NIDDK**
NCCAM	**NIAID**	**NIEHS**
NCI	**NIAMS**	**NIGMS**
NCRR	**NIBIB**	**NIMH**
NEI	**NICHD**	**NINDS**
NHGRI	**NIDA**	**NINR**
NHLBI	**NIDCD**	**NLM**

Publication Count by IC

1995 – Present

Current as of November 25, 2007

NCI	122683	NICHD	44923	NIDCR	14848
NIGMS	105013	NIA	40384	NHGRI	5336
NHLBI	100898	NIDA	27846	NIBIB	5061
NIDDK	78250	NEI	26836	FIC	4683
NIAID	77123	NIEHS	25015	NINR	4527
NINDS	62982	NIAMS	24620	NLM	3076
NCRR	51345	NIAAA	15516	NCCAM	1977
NIMH	50246	NIDCD	14869	CSR	5

SPIRES Publication Count by Pub Year

(11/25/07)

1995	47206
1996	47077
1997	47047
1998	47845
1999	50841
2000	52647
2001	53527
2002	55439
2003	59126
2004	63496
2005	66041
2006	68560
2007	55231

Pub. to Project Number Matches

1995 – Present

Current as of November 25, 2007

NCI	228059	NICHD	72557	NIDCR	23784
NHLBI	183420	NIA	70324	NHGRI	7842
NIGMS	178603	NIDA	58001	FIC	7169
NIAID	141203	NEI	55513	NIBIB	6206
NIDDK	127582	NIEHS	46168	NINR	5411
NINDS	100908	NIAMS	35925	NLM	4409
NIMH	100031	NIAAA	30180	NCCAM	2428
NCRR	81695	NIDCD	28336	CSR	6

SPIRES Oracle Text Searches

- *Publication Data that is text indexed:*
  - Publication Titles
  - Publication Abstracts
  - Publication MESH terms
- *Project Data that is text indexed:*
  - Project Title
  - Project Abstracts
  - Project CRISP terms

Can be searched simultaneously or separately.

Note: text searches are database intensive!

SPIRES Daily Update Process - 1

- The original NIEHS SPIRES system could only be updated once monthly, due to the labor intensive nature of downloading and refreshing the data.
- NIH SPIRES uses new technology to search PubMed automatically, each day, for new and revised publications.
- *The daily update process handles all aspects of the load process, from raw data to finished database records that are linked to projects.*

SPIRES Daily Update Process - 2

- *The daily update process looks for*
  - New publications not in SPIRES, using the standard criteria applied to the GRANT tag.
  - Publications where the last revised date has changed.
  - Publications where the MeSH terms indexing date has changed.

SPIRES Daily Update Process

How it works - 1

- Step I: Pubmed Download
  - Search PubMed for the following data types for designated NIH IC codes and download data:
    - New Records, not in SPIRES
    - Revised Records (existing)
    - MeSH terms updated (existing)
- Step 2: IRDB Project Table Update
  - Builds a project number lookup table optimized for speed in matching pubs to projects.

SPIRES Daily Update Process

How it works - 2

- Step III: Unpack Publications
  - Complex, multi-step process for translating and decoding publication data into usable format for SPIRES.
    - Makes extensive use of XML parsing techniques.
    - Extraction of data elements makes possible Oracle text indexing of pub data as well as optimizing data structures for querying.

SPIRES Daily Update Process

How it works - 3

- Step IV: Decode Grant Strings
  - Complex, multi-step process using pattern matching algorithms.
  - Extensive recursive processing for best possible result.
  - PL-SQL procedures and other techniques.

SPIRES Daily Update Process

How it works - 4

- Step V: Match Grant Numbers
  - Match decoded project numbers with eRA project numbers.
  - Assign score to each match based on quality of match.
- Step VI: Complete Load Table Build
- Step VII: Build PUB_SUMMARY_T
- Step VIII: Push to Production Tables.

Decoding NIH Grant Numbers

- Project Number data is available for a majority of the publication records downloaded from PUBMED.
- Each publication record may reference several NIH grant numbers.
- Grant numbers in PubMed are NOT stored in eRA recognized format.
- Many different string formats have been used in the system over the years.

Decoding NIH Grant Numbers
(continued)

- A few examples of the variations in grant number string formats:
  - 1-R03-TW01490-01A/TW/FIC
  - 5 R03 TW00857/TW/FIC
  - GM-14312/GM/NIGMS
  - P41RR-04293/RR/NCRR
  - TW1064/TW/FIC
  - R03 TW1064/TW/FIC
  - U01-TW01015-01/TW/FIC
  - AI 47053/AI/NIAID
  - HD-24870/HD/NICHD

This is only a sampling. There are many more!

Decoding and Matching Grant Numbers

- SPIRES only matches on the base grant number: *Activity Code+IC+Serial Number*.
- Grant number string components are decoded from raw data using pattern matching algorithms that have been refined over the last 6 years.
- Decoded components are then matched to eRA project numbers in IRDB.
- Resulting matches are scored based on the quality of match.

SPIRES Match Case Score System

Rates the "match quality" for each project number

Match Case #5 NIH activity code = PUBMED activity code NIH org code = PUBMED org code NIH serial number = PUBMED serial number	In match case #5, the Project Number from the publication matches all three components of the NIH Database Project Number.
Match Case #4 (1 row matched) PUBMED activity code IS NULL PUBMED org code = NIH org code PUBMED serial number = NIH serial number	In match case #4, the activity code was not found or could not be decoded. The IC code and the serial number matched **one** NIH Database Project Number.
Match Case #3 (> 1 row matched) PUBMED activity code IS NULL PUBMED org code = NIH org code PUBMED serial number = NIH serial number	In match case #3, the activity code was not found or could not be decoded. The IC code and the serial number matched **more than one** NIH Database Project Number.
Match Case #2 PUBMED activity code = NIH activity code PUBMED org code = NIH org code PUBMED serial number IS NULL	In match case #2, the serial number was not found or could not be decoded. The activity code and the org code matched one or more NIH Database Project Numbers.
Match Case #1 PUBMED activity code = NIH activity code PUBMED org code DOES NOT MATCH PUBMED serial number = NIH serial number	In match case #1, the activity code and serial number were matched to an NIH Database Project Number, however the IC code was not matched.

Matching Process: Summary Stats

Statistics as of November 25, 2007

	Total Number of records with match case of 5	426,982
	% of matched records with match case of 5	26.53 %
	Total Number of records with match case of 4	628,868
	% of matched records with match case of 4	39.08 %
	Total Number of records with match case of 3	545,134
	% of matched records with match case of 3	33.87 %
	Total Number of records with match case of 2	1,581
	% of matched records with match case of 2	0.10%
	Total Number of records with match case of 1	6,753
	% of matched records with match case of 1	0.42%

Overall Success for Decoding/Matching

SPIRES Pub to Project Match Success Rate:

98.48%

(projects matched at some level)

a	**Total Publications Downloaded to Date**	716,487
b	**Total Number of Rows in Match Table (possible matches)**	1,609,318
c	**Total Number of DISTINCT Pubs Matched**	705,629
d	**% of Publications Decoded and Matched at Some Level ((c / a)*100)**	98.48%

Statistics as of November 25, 2007

Third Party Data in SPIRES

- Journal Impact Factors
  - Impact factor data has been loaded for 1997 through 2005.
- Publication Citation Data
  - Citation data is a valuable tool in analyzing publication data.
  - Citation data must be purchased from ISI.
  - Adding citation data would greatly expand the potential of the SPIRES data.

Current Project Status

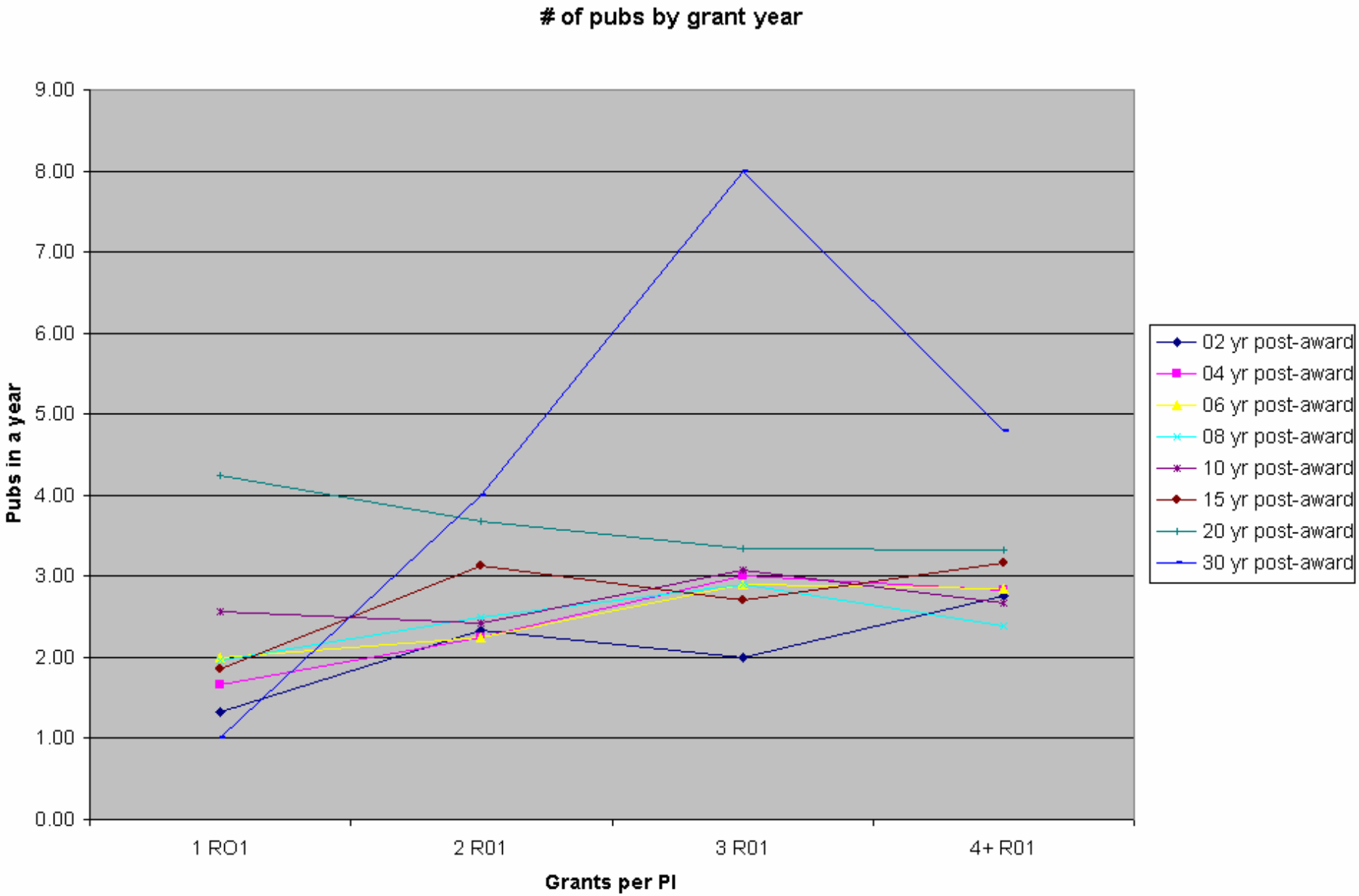
- The initial database load for NIH SPIRES was completed in February 2006.
- The daily update process for database maintenance was completed in March 2006. The system is currently in beta mode.
- Feb. 2007: Data analysis project for NIH Director's Office.
- Fall 2007 Work in progress: development of web services, loading pubs for 1985 to 1994, development of a new PI/author matching algorithm.
- Partnership with QVR: NEW Bibliography Report in beta!

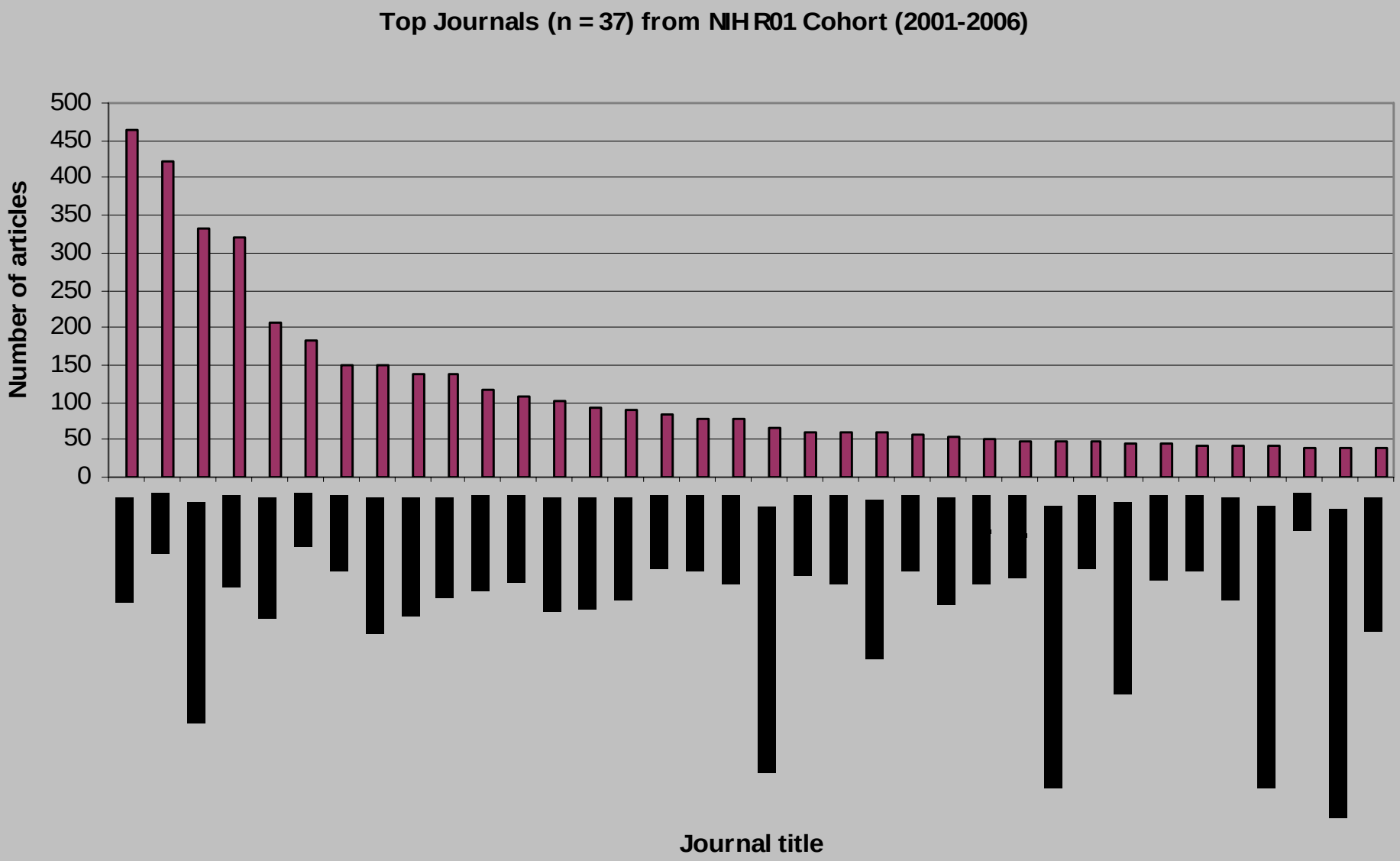
New: QVR Bibliography Report (beta)

- Obtain a SPIRES bibliography report from selected projects resulting from QVR searches.
- Report is available in Program section of standard reports listing in QVR.
- Report is downloaded to your local machine in Excel pivot table format.
- Two formats offered: project summary and standard bibliography.

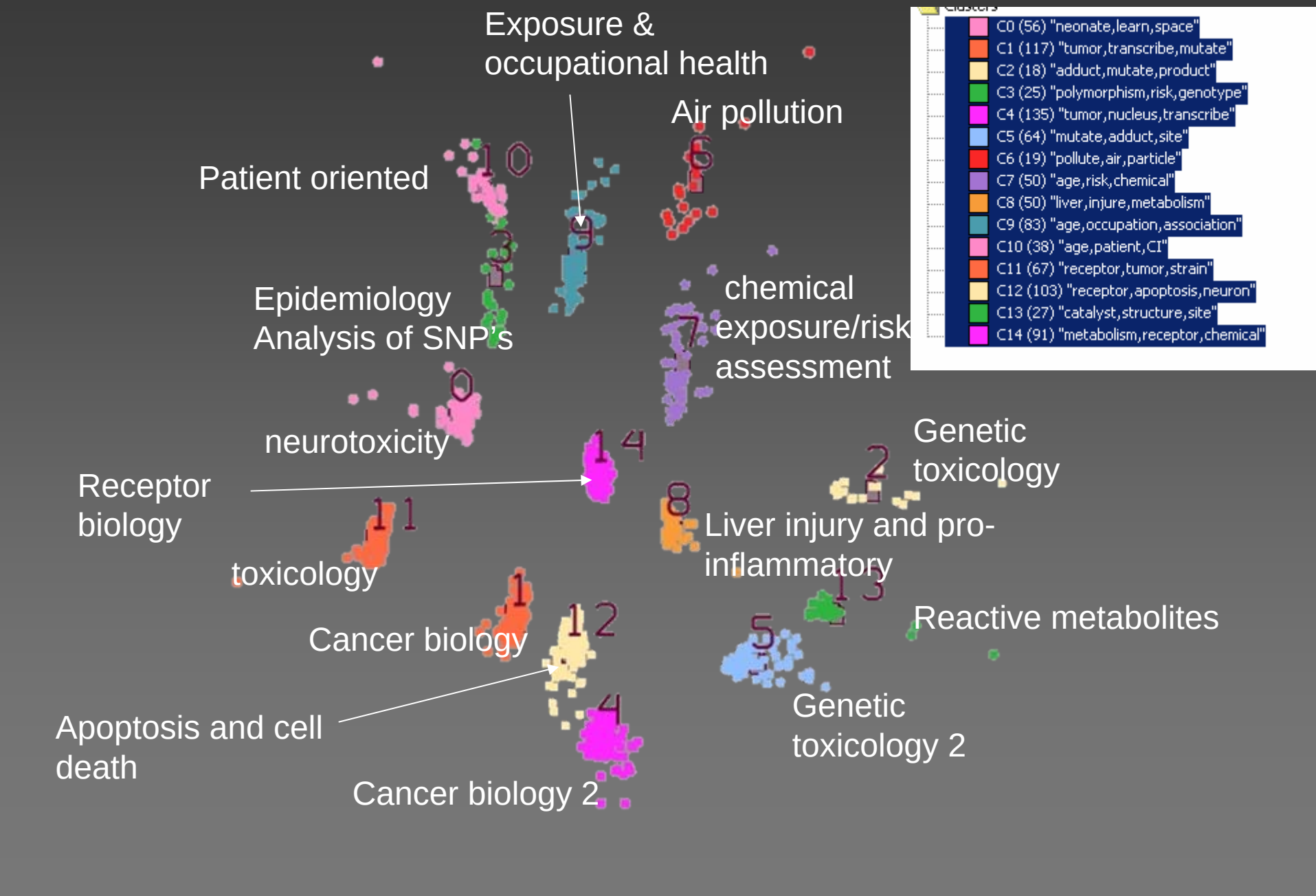
Analysis Projects Using SPIRES Data

1. Graph of R01s Showing correlation between number of grants per PI and number of papers published over time.
2. Top 20 journals publishing NIH supported research 2001 – 2006.
3. NIEHS T32 supported papers clustered by MeSH terms.


# of pubs by grant year
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Pubs in a year
1 RO1
2 R01
3 R01
4+ R01
Grants per PI
02 yr post-award
04 yr post-award
06 yr post-award
08 yr post-award
10 yr post-award
15 yr post-award
20 yr post-award
30 yr post-award


Top Journals (n = 37) from NIH R01 Cohort (2001-2006)
Number of articles
500
450
400
350
300
250
200
150
100
50
0
Journal title

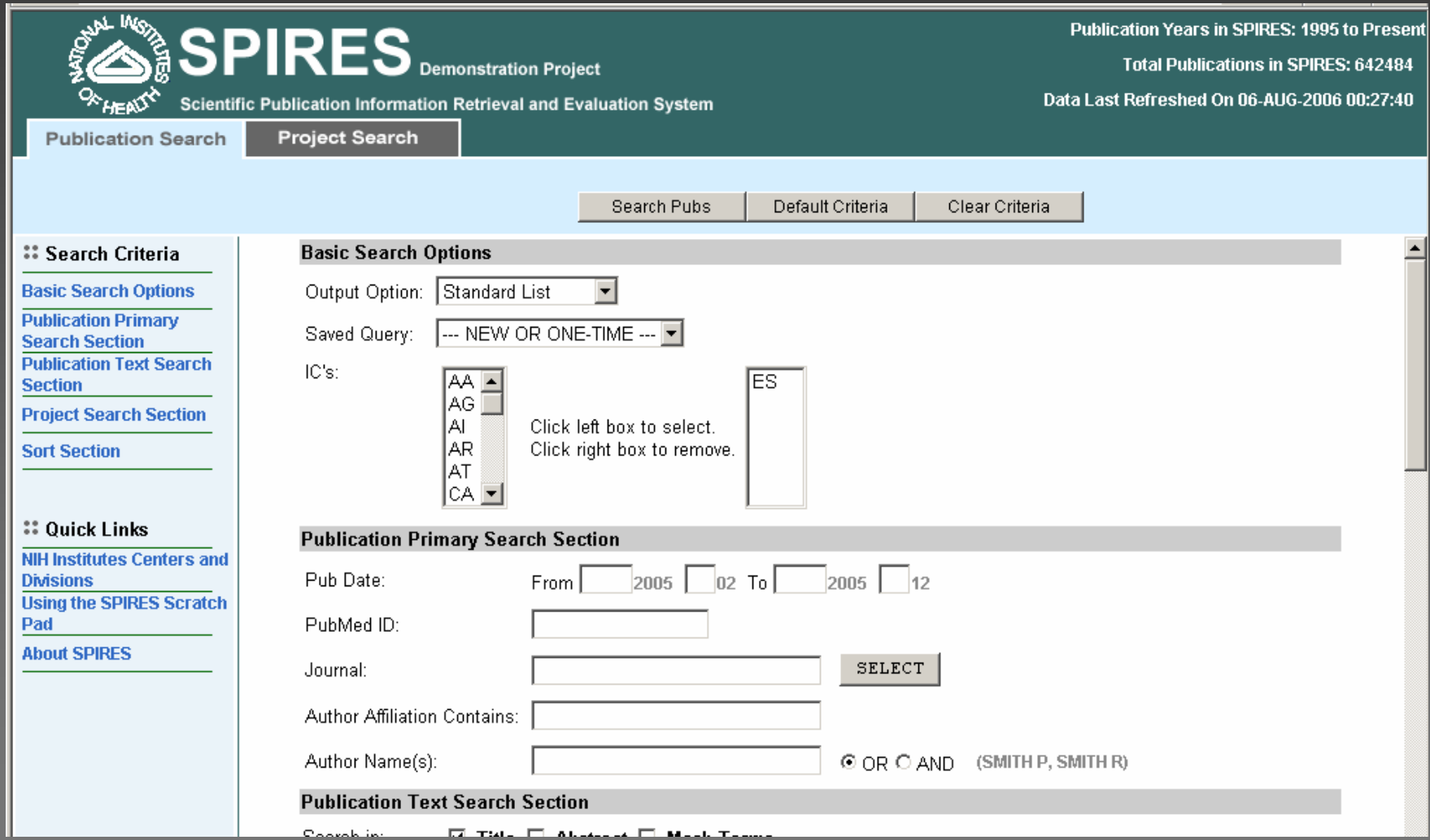
OmniViz galaxy view of T32 supported papers 2000-2006, N = 943, clustered into 15 groups of papers, mesh terms included, many terms demoted



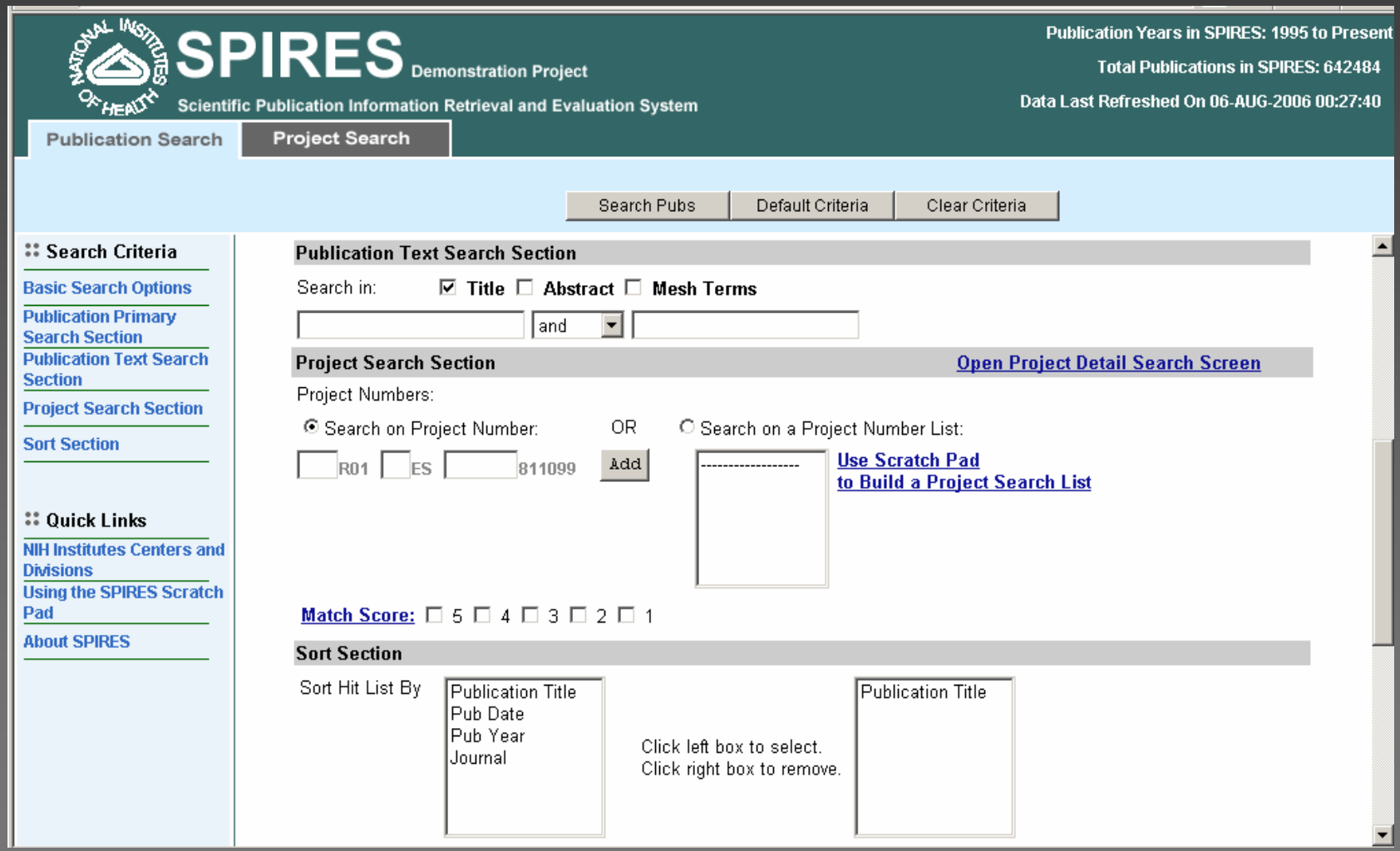
SPIRES Sample Queries

- Publication Search Screenshots
- Project Search Screenshots
- Example Query 1: Publication Search
- Example Query 2: Project Search

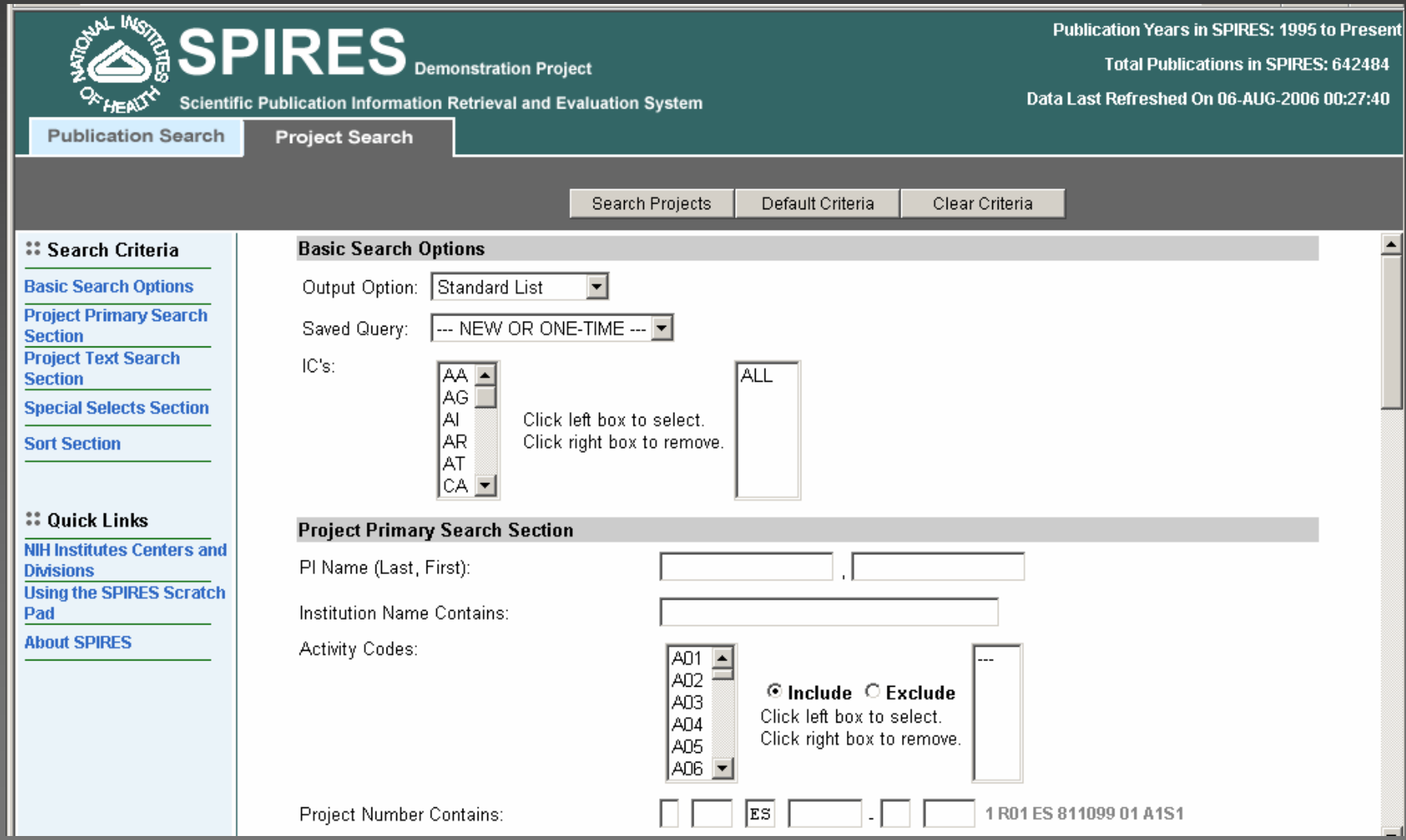
SPIRES Publication Search Screen (1)



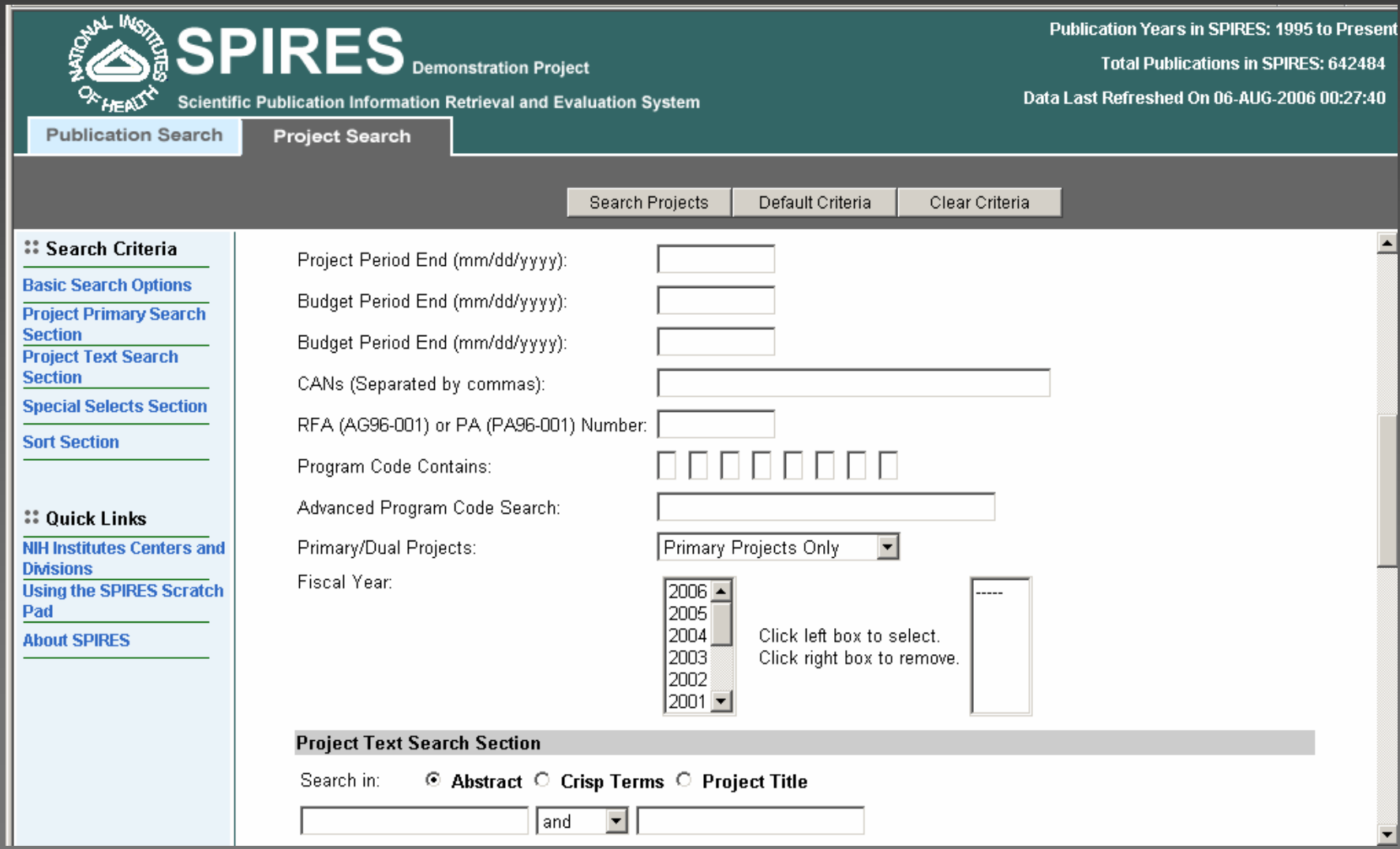
SPIRES Publication Search Screen (2)



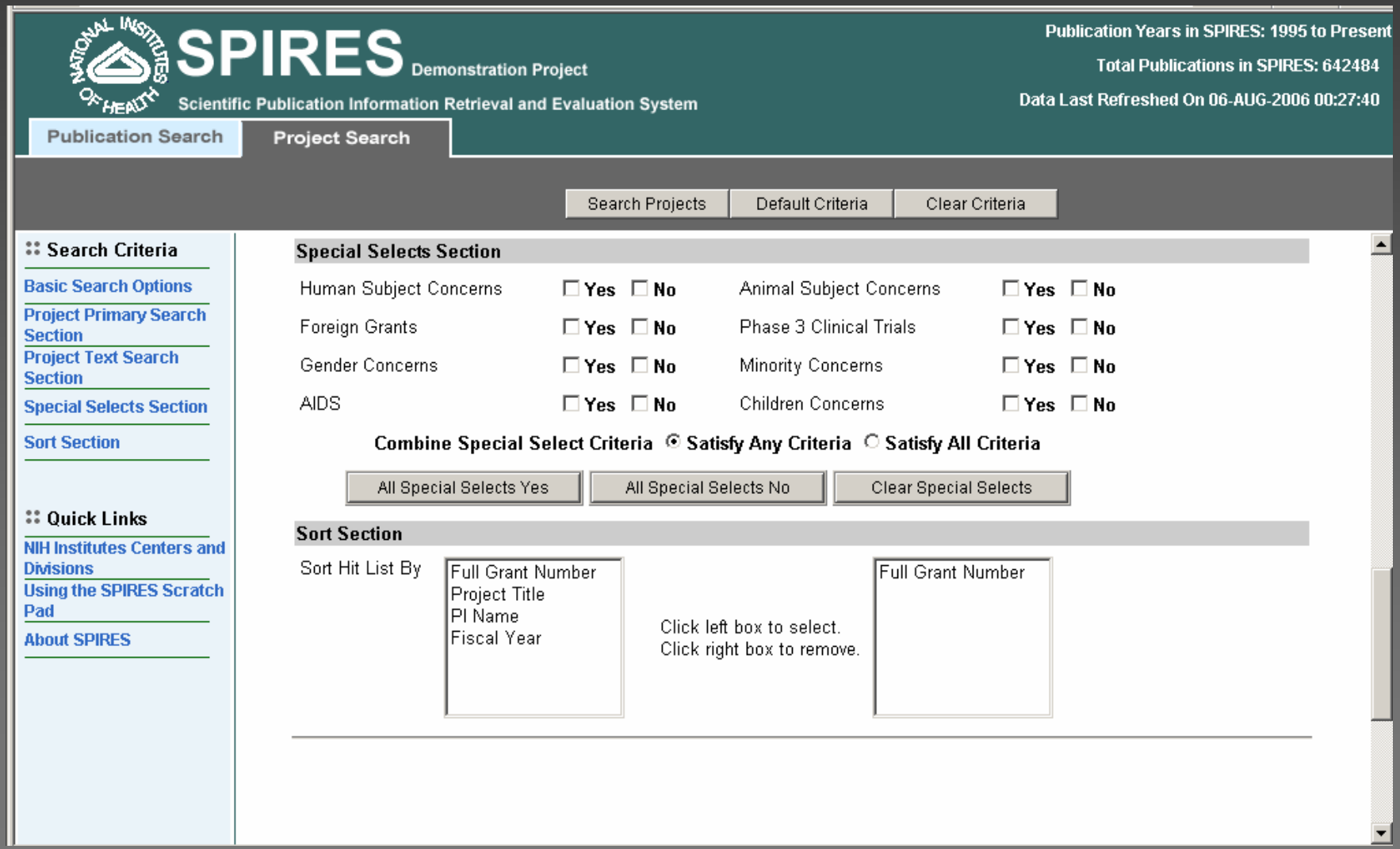
SPIRES Project Search Screen (1)



SPIRES Project Search Screen (2)



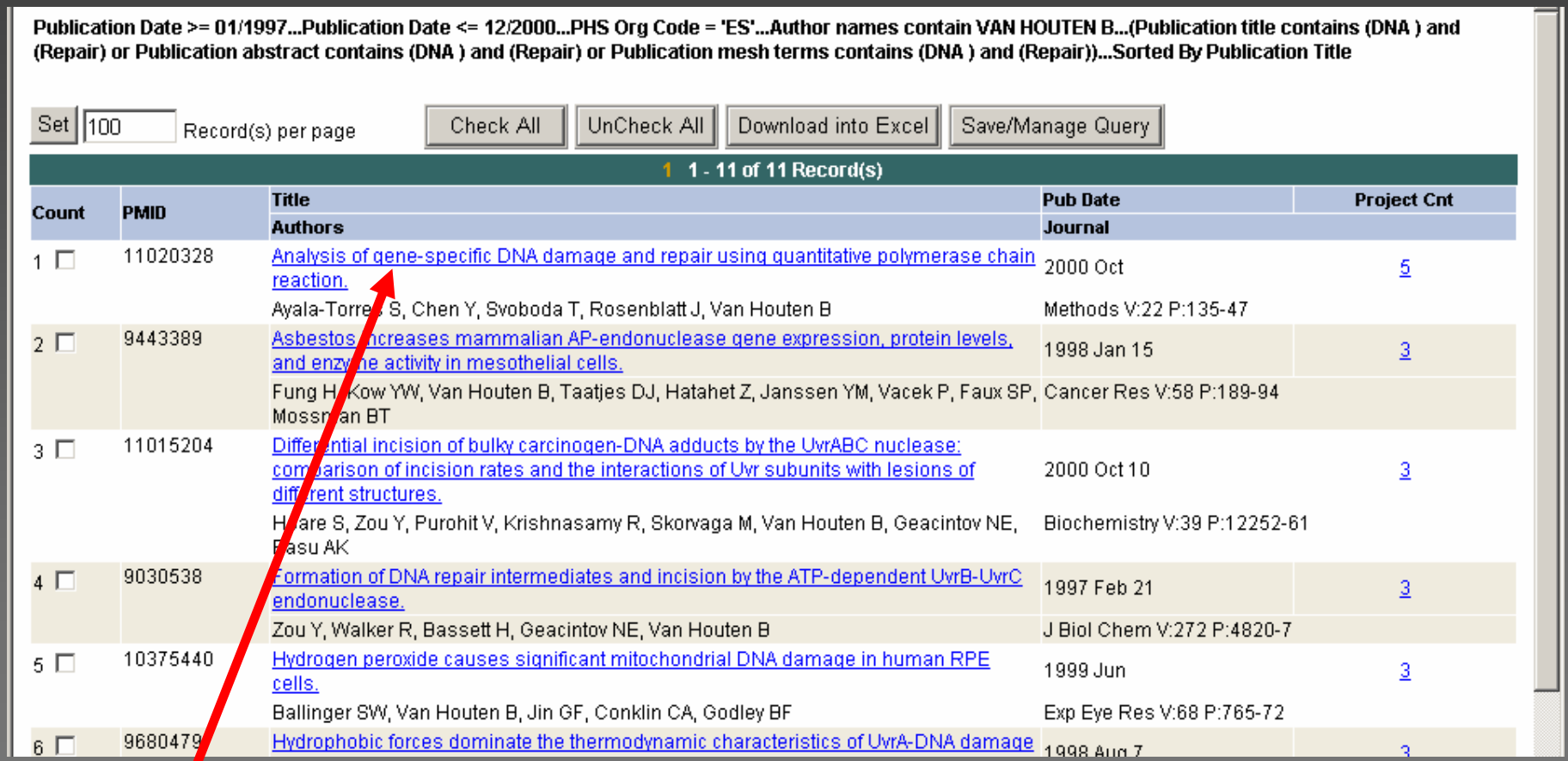
SPIRES Project Search Screen (3)



SPIRES Sample Queries
Example 1- Publication Search

- *On Publication Search Page, enter:*
  - IC = NIEHS
  - Pub Date= 1997 Jan to 2000 Dec
  - Author Name = VAN HOUTEN B
- *Search Results in 15 Publications*
- *Further limit search, enter:*
  - Publication Text Search:
    - Search in Title, Abstract, MeSH Terms:
    - DNA and REPAIR
- *New Search Results in 11 Publications*

Example 1- Publication Search: Publication Search - Basic Hit List



Publication Date >= 01/1997...Publication Date <= 12/2000...PHS Org Code = 'ES'...Author names contain VAN HOUTEN B...(Publication title contains (DNA) and (Repair) or Publication abstract contains (DNA) and (Repair) or Publication mesh terms contains (DNA) and (Repair))...Sorted By Publication Title

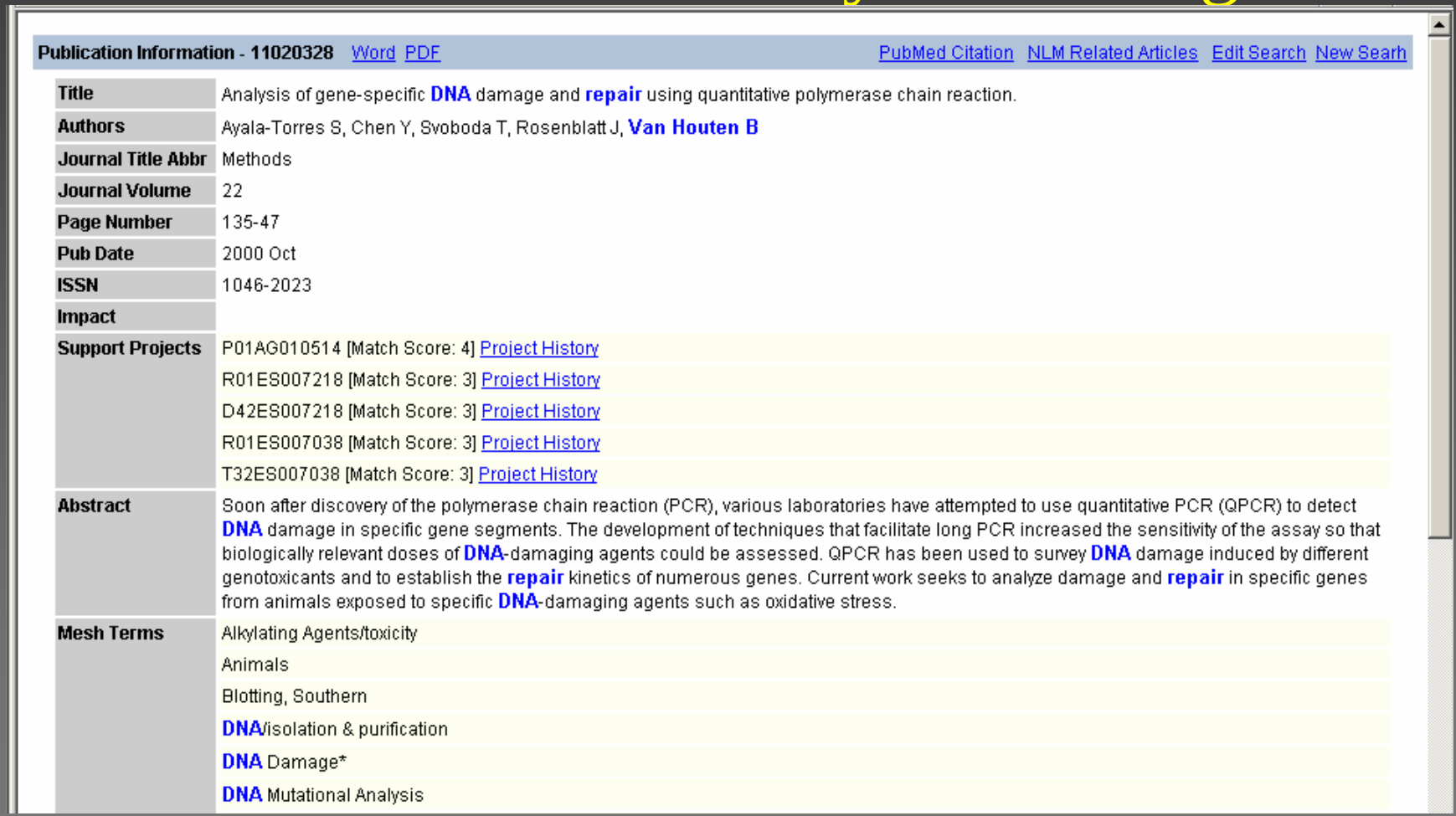
Set 100 Record(s) per page | Check All | UnCheck All | Download into Excel | Save/Manage Query

1 1 - 11 of 11 Record(s)

Count	PMID	Title / Authors	Pub Date / Journal	Project Cnt
1	11020328	Analysis of gene-specific DNA damage and repair using quantitative polymerase chain reaction. Ayala-Torres S, Chen Y, Svoboda T, Rosenblatt J, Van Houten B	2000 Oct Methods V:22 P:135-47	5
2	9443389	Asbestos increases mammalian AP-endonuclease gene expression, protein levels, and enzyme activity in mesothelial cells. Fung H, Kow YW, Van Houten B, Taatjes DJ, Hatahet Z, Janssen YM, Vacek P, Faux SP, Mossman BT	1998 Jan 15 Cancer Res V:58 P:189-94	3
3	11015204	Differential incision of bulky carcinogen-DNA adducts by the UvrABC nuclease: comparison of incision rates and the interactions of Uvr subunits with lesions of different structures. Hoare S, Zou Y, Purohit V, Krishnasamy R, Skorvaga M, Van Houten B, Geacintov NE, Basu AK	2000 Oct 10 Biochemistry V:39 P:12252-61	3
4	9030538	Formation of DNA repair intermediates and incision by the ATP-dependent UvrB-UvrC endonuclease. Zou Y, Walker R, Bassett H, Geacintov NE, Van Houten B	1997 Feb 21 J Biol Chem V:272 P:4820-7	3
5	10375440	Hydrogen peroxide causes significant mitochondrial DNA damage in human RPE cells. Ballinger SW, Van Houten B, Jin GF, Conklin CA, Godley BF	1999 Jun Exp Eye Res V:68 P:765-72	3
6	9680479	Hydrophobic forces dominate the thermodynamic characteristics of UvrA-DNA damage	1998 Aug 7	3

Click **Title** to bring up summary screen for that publication

Example 1- Publication Search: Publication Summary Detail Page



Publication Information - 11020328 Word PDF PubMed Citation NLM Related Articles Edit Search New Search

Title	Analysis of gene-specific **DNA** damage and **repair** using quantitative polymerase chain reaction.
Authors	Ayala-Torres S, Chen Y, Svoboda T, Rosenblatt J, **Van Houten B**
Journal Title Abbr	Methods
Journal Volume	22
Page Number	135-47
Pub Date	2000 Oct
ISSN	1046-2023
Impact	
Support Projects	P01AG010514 [Match Score: 4] Project History
	R01ES007218 [Match Score: 3] Project History
	D42ES007218 [Match Score: 3] Project History
	R01ES007038 [Match Score: 3] Project History
	T32ES007038 [Match Score: 3] Project History
Abstract	Soon after discovery of the polymerase chain reaction (PCR), various laboratories have attempted to use quantitative PCR (QPCR) to detect **DNA** damage in specific gene segments. The development of techniques that facilitate long PCR increased the sensitivity of the assay so that biologically relevant doses of **DNA**-damaging agents could be assessed. QPCR has been used to survey **DNA** damage induced by different genotoxicants and to establish the **repair** kinetics of numerous genes. Current work seeks to analyze damage and **repair** in specific genes from animals exposed to specific **DNA**-damaging agents such as oxidative stress.
Mesh Terms	Alkylating Agents/toxicity
	Animals
	Blotting, Southern
	DNA/isolation & purification
	DNA Damage*
	DNA Mutational Analysis

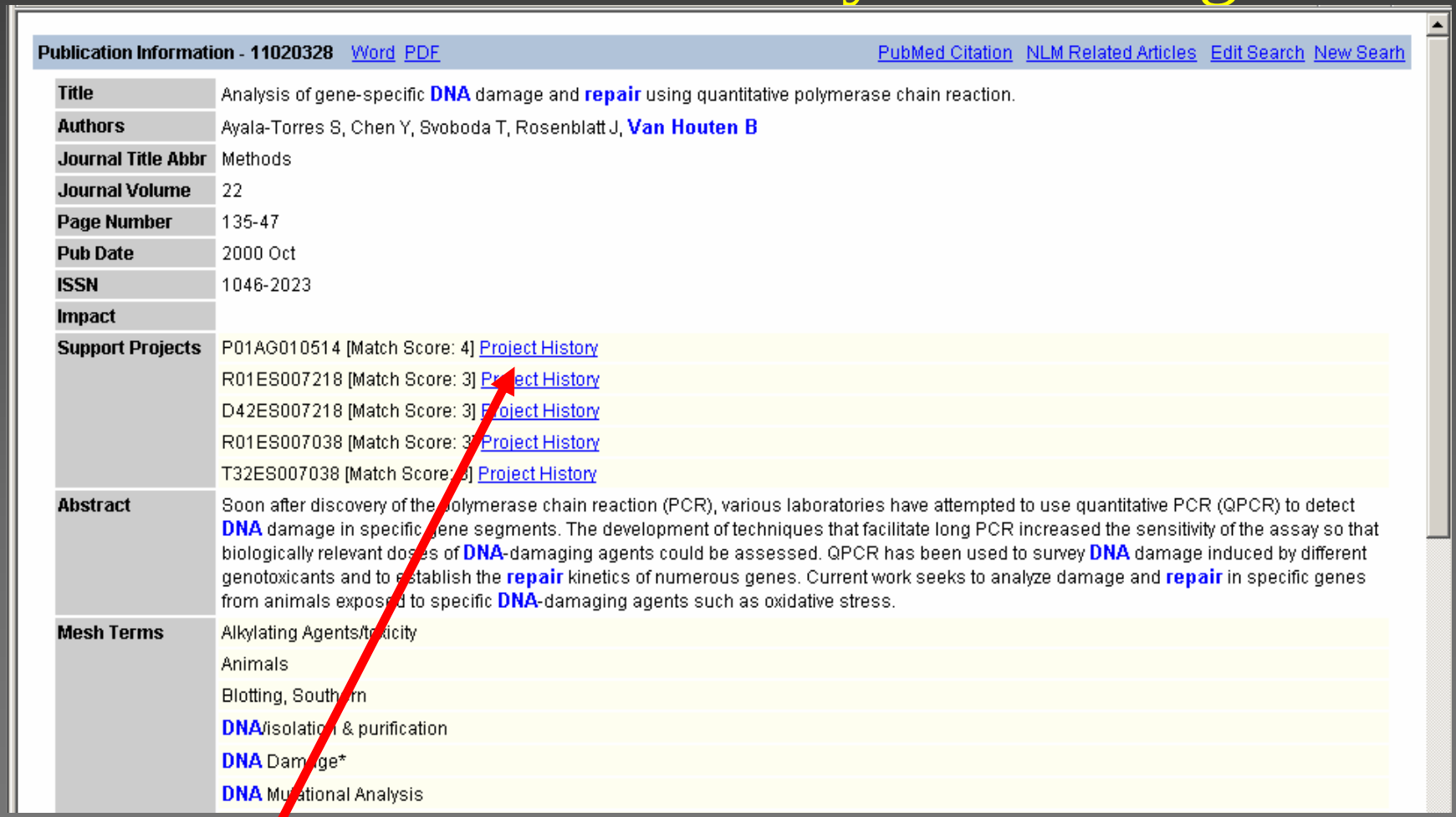
Features: links to project history, searched words highlighted

Example 1- Publication Search: Publication Summary Detail Page

Publication Detail Screen Features:

- All basic publication information
- Publication abstract
- All searched words highlighted
- NIH supported projects cited by author
  - Project numbers linked to project history
  - Match score value indicates quality of grant number match.

Example 1- Publication Search: Publication Summary Detail Page



Publication Information - 11020328 Word PDF PubMed Citation NLM Related Articles Edit Search New Search

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Impact	
Support Projects	P01AG010514 [Match Score: 4] Project History R01ES007218 [Match Score: 3] Project History D42ES007218 [Match Score: 3] Project History R01ES007038 [Match Score: 3] Project History T32ES007038 [Match Score: 3] Project History
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Mesh Terms	Alkylating Agents/toxicity Animals Blotting, Southern **DNA**/isolation & purification **DNA** Damage* **DNA** Mutational Analysis

Click Project History Link for More Information

Example 1- Publication Search: Project History Summary Page

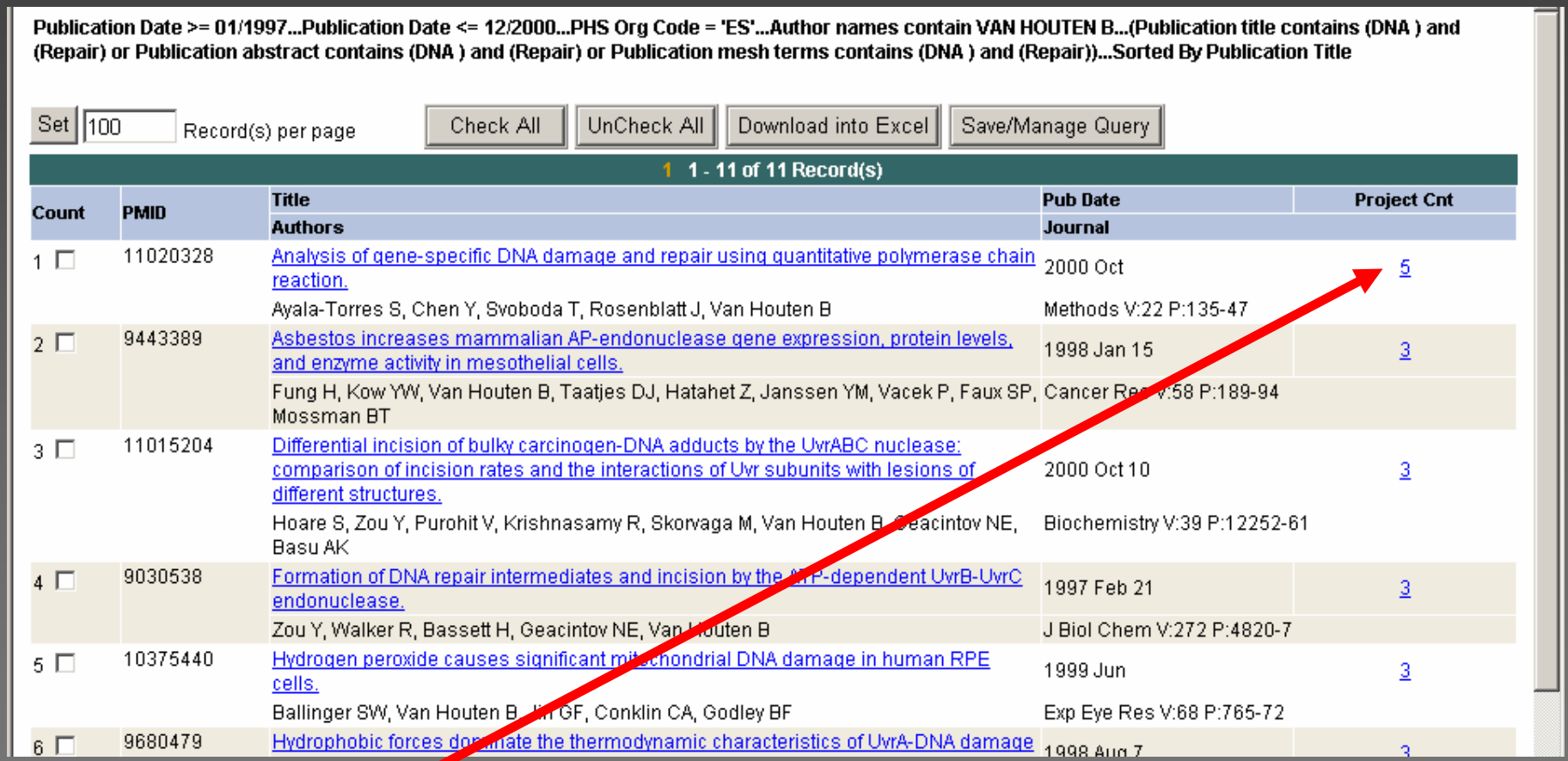
Project History - P01AG010514 Publications: 72 Publications Spreadsheet Project Spreadsheet Edit Search New Search

Cnt	Fiscal Year	Project No.	RFA/PA	PCC	PI	Project Title
1	2001	5P01AG010514-10		1ACSFFS	PAPACONSTANTINOU, JOHN	AGING EFFECTS ON MOLECULAR RESPONSES TO STRESS
2	2000	5P01AG010514-09		1ACSFFS	PAPACONSTANTINOU, JOHN	AGING EFFECTS ON MOLECULAR RESPONSES TO STRESS
3	1999	5P01AG010514-08		1ACSFFS	PAPACONSTANTINOU, JOHN	AGING EFFECTS ON MOLECULAR RESPONSES TO STRESS
4	1999	3P01AG010514-07S1		1ACSFFS	PAPACONSTANTINOU, JOHN	AGING EFFECTS ON MOLECULAR RESPONSES TO STRESS
5	1998	5P01AG010514-07		1ACSFFS	PAPACONSTANTINOU, JOHN	AGING EFFECTS ON MOLECULAR RESPONSES TO STRESS
6	1997	2P01AG010514-06		1ACSFDF	PAPACONSTANTINOU, JOHN	AGING EFFECTS ON MOLECULAR RESPONSES TO STRESS
7	1996	5P01AG010514-05		1BPBYDF	PAPACONSTANTINOU, JOHN	AGING EFFECTS ON MOLECULAR RESPONSES TO STRESS
8	1995	5P01AG010514-04		1BPBYDF	PAPACONSTANTINOU, JOHN	AGING EFFECTS ON MOLECULAR RESPONSES TO STRESS
9	1994	5P01AG010514-03		1BPBYDF		AGING EFFECTS ON MOLECULAR RESPONSES TO STRESS
10	1993	5P01AG010514-02		1BPBYDF		EFFECTS OF AGING ON MOLECULAR RESPONSES TO STRESS
11	1992	1P01AG010514-01		1BPBYDF		EFFECTS OF AGING ON MOLECULAR RESPONSES TO STRESS

Project History page features:

- Download spreadsheet of all publications related to this project
- Download current page project data into spreadsheet
- *Coming Soon:* Project Title links to summary statement

Example 1- Publication Search: Publication Search - Basic Hit List (2)



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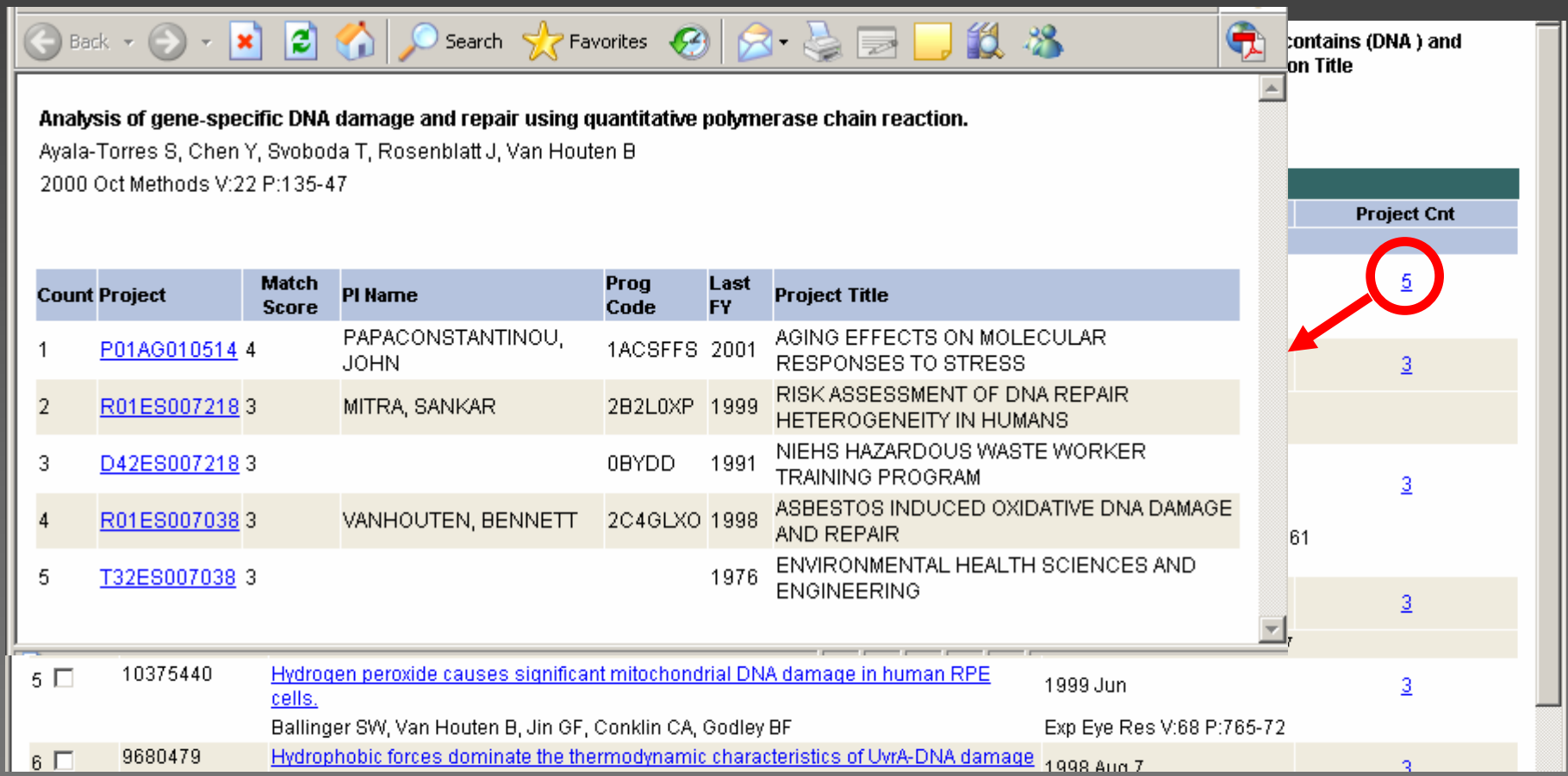
6	9680479	Hydrophobic forces dominate the thermodynamic characteristics of UvrA-DNA damage	1998 Aug 7	3

Click **Project Count** to bring up project list for a publication

Example 1- Publication Search: Project Support List for Publication



Analysis of gene-specific DNA damage and repair using quantitative polymerase chain reaction.
Ayala-Torres S, Chen Y, Svoboda T, Rosenblatt J, Van Houten B
2000 Oct Methods V:22 P:135-47

Count	Project	Match Score	PI Name	Prog Code	Last FY	Project Title
1	P01AG010514	4	PAPACONSTANTINOU, JOHN	1ACSFFS	2001	AGING EFFECTS ON MOLECULAR RESPONSES TO STRESS
2	R01ES007218	3	MITRA, SANKAR	2B2L0XP	1999	RISK ASSESSMENT OF DNA REPAIR HETEROGENEITY IN HUMANS
3	D42ES007218	3		0BYDD	1991	NIEHS HAZARDOUS WASTE WORKER TRAINING PROGRAM
4	R01ES007038	3	VANHOUTEN, BENNETT	2C4GLXO	1998	ASBESTOS INDUCED OXIDATIVE DNA DAMAGE AND REPAIR
5	T32ES007038	3			1976	ENVIRONMENTAL HEALTH SCIENCES AND ENGINEERING

contains (DNA) and
on Title

Project Cnt

5 10375440 Hydrogen peroxide causes significant mitochondrial DNA damage in human RPE cells. 1999 Jun 3
Ballinger SW, Van Houten B, Jin GF, Conklin CA, Godley BF Exp Eye Res V:68 P:765-72

6 9680479 Hydrophobic forces dominate the thermodynamic characteristics of UvrA-DNA damage 1998 Aug 7 3

- Click **Project Count** to bring up pub project support list.
- Click **Project Number** to bring up Project History.

SPIRES Sample Queries
Example 2- Project Search

- *On Project Search Page, enter:*
  - IC = NIEHS
  - FY = 1997, 1998, 1999, 2000
  - Project Text Search:
    - Search in Project Title for:
    - CHEMICAL and MIXTURES
- *Search Results in 25 project records, listed by individual support year.*

Example 2- Project Search:
Project Search - Basic Hit List

Project Title contains '(Chemical) and (Mixtures)'Fisal Year = '1997' or '1998' or '1999' or '2000'...ICs ='ES'...Primary Projects...Sorted By Full Grant Number

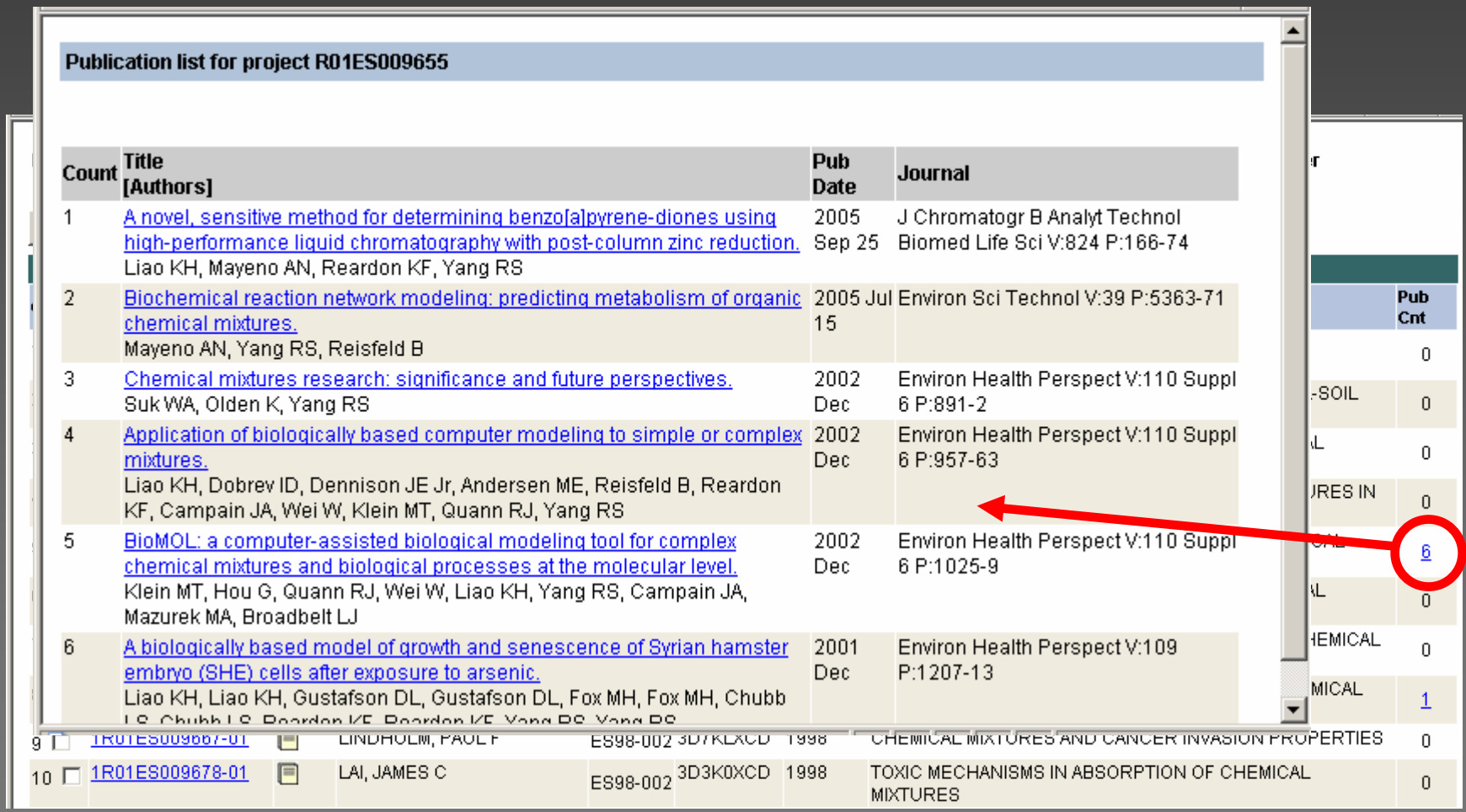
Set 100 Record(s) per page | Check All | UnCheck All | Add to Scratch Pad | Download All into One Excel | Save/Manage Query

1 1 - 25 of 25 Record(s)

Count	Project	History	PI Name	RFA/PA	Prog Code	Fiscal Year	Project Title	Pub Cnt
1	1R01ES007763-01A1		SHANK, RONALD C		2D2K0XC	1997	MECHANISMS IN THE GENOTOXICITY OF CHEMICAL MIXTURES	0
2	1R01ES009630-01		BUNGE, ANNETTE L	ES98-002	2D8K0XCD	1998	ASSESSING RISKS FROM EXPOSURE TO CHEMICAL-SOIL MIXTURES	0
3	1R01ES009640-01		DODSON, STANLEY I	ES98-002	3D2KEXCD	1998	A NOVEL METHOD FOR CHARACTERIZING CHEMICAL MIXTURES	0
4	1R01ES009646-01		TASH, JOSEPH S	ES98-002	2D2KEXCD	1998	A MODEL ASSESSING TOXICITY OF CHEMICAL MIXTURES IN SPERM	0
5	1R01ES009655-01		YANG, RAYMOND S	ES98-002	3D8K0XCD	1998	DEVELOPING A PREDICTIVE STRATEGY FOR CHEMICAL MIXTURES	6
6	1R01ES009661-01		SAFFER, JEFFREY D	ES98-002	3D7K0XCD	1999	MOLECULAR MECHANISMS OF ACTION OF CHEMICAL MIXTURES	0
7	1R01ES009663-01		SHULER, MICHAEL L	ES98-002	3D3K0XCD	1998	PBPK MODELS & CELL CULTURE ANALOGS FOR CHEMICAL MIXTURES	0
8	1R01ES009664-01		HALL, FRANKLIN R	ES98-002	3D8K0XCD	1998	MIXTURE MODELS FOR RISK ASSESSMENT OF CHEMICAL MIXTURES	1
9	1R01ES009667-01		LINDHOLM, PAUL F	ES98-002	3D7KLXCD	1998	CHEMICAL MIXTURES AND CANCER INVASION PROPERTIES	0
10	1R01ES009678-01		LAI, JAMES C	ES98-002	3D3K0XCD	1998	TOXIC MECHANISMS IN ABSORPTION OF CHEMICAL MIXTURES	0

- Click Project Number to bring up project summary statement
- Click Publication Count to bring up all pubs related to this project
- Click HISTORY icon to bring up project history hit list
- *CHECK projects you wish to add to a new publication search query*

Example 2- Project Search: List of All Pubs for Selected Project



Publication list for project R01ES009655

Count	Title [Authors]	Pub Date	Journal
1	A novel, sensitive method for determining benzo[a]pyrene-diones using high-performance liquid chromatography with post-column zinc reduction. Liao KH, Mayeno AN, Reardon KF, Yang RS	2005 Sep 25	J Chromatogr B Analyt Technol Biomed Life Sci V:824 P:166-74
2	Biochemical reaction network modeling: predicting metabolism of organic chemical mixtures. Mayeno AN, Yang RS, Reisfeld B	2005 Jul 15	Environ Sci Technol V:39 P:5363-71
3	Chemical mixtures research: significance and future perspectives. Suk WA, Olden K, Yang RS	2002 Dec	Environ Health Perspect V:110 Suppl 6 P:891-2
4	Application of biologically based computer modeling to simple or complex mixtures. Liao KH, Dobrev ID, Dennison JE Jr, Andersen ME, Reisfeld B, Reardon KF, Campain JA, Wei W, Klein MT, Quann RJ, Yang RS	2002 Dec	Environ Health Perspect V:110 Suppl 6 P:957-63
5	BioMOL: a computer-assisted biological modeling tool for complex chemical mixtures and biological processes at the molecular level. Klein MT, Hou G, Quann RJ, Wei W, Liao KH, Yang RS, Campain JA, Mazurek MA, Broadbelt LJ	2002 Dec	Environ Health Perspect V:110 Suppl 6 P:1025-9
6	A biologically based model of growth and senescence of Syrian hamster embryo (SHE) cells after exposure to arsenic. Liao KH, Liao KH, Gustafson DL, Gustafson DL, Fox MH, Fox MH, Chubb	2001 Dec	Environ Health Perspect V:109 P:1207-13

Pub Cnt

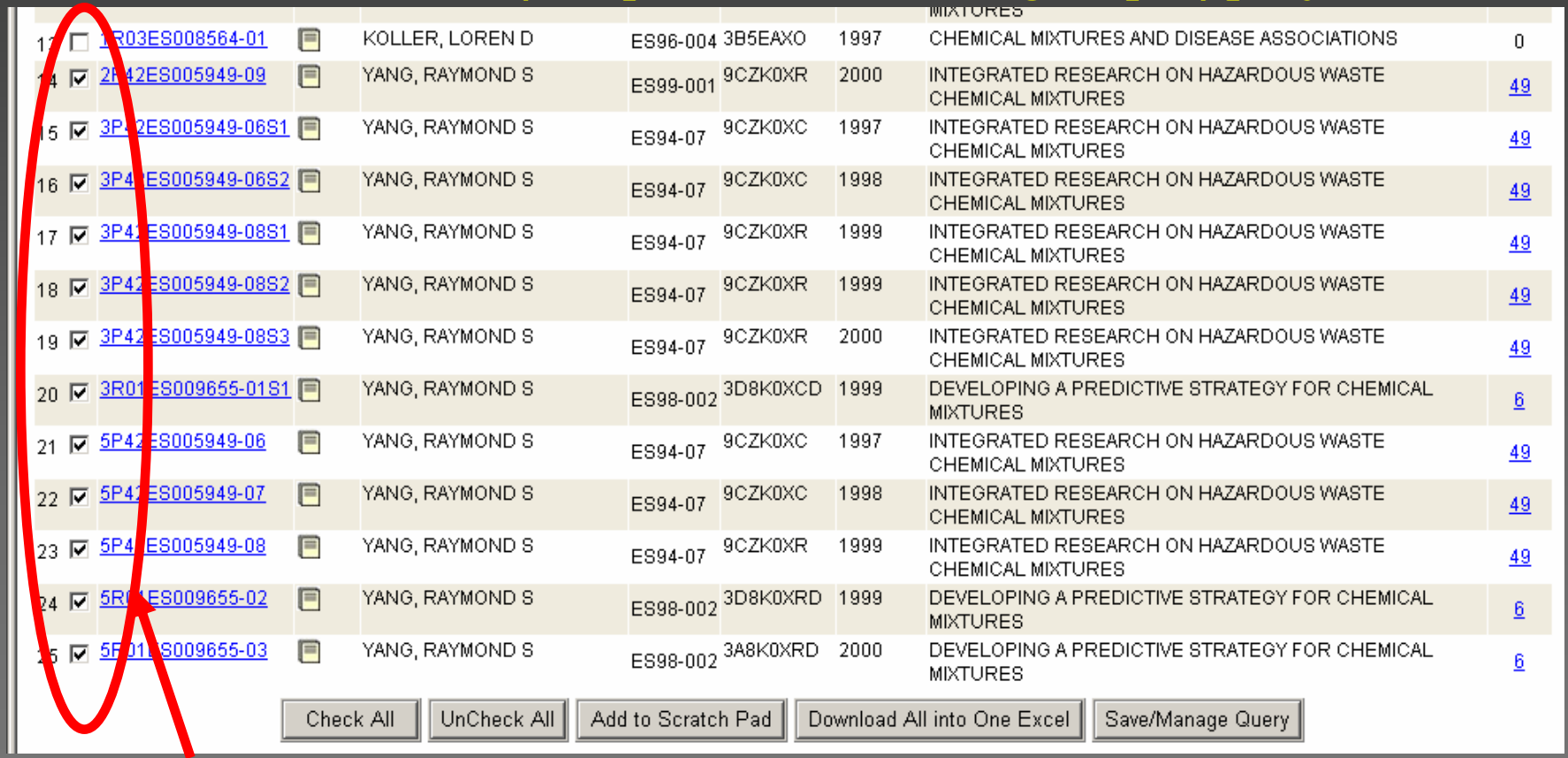
0
0
0
6
0
0
1
0
0

9	1R01ES009667-01	LINDHOLM, PAUL F	ES98-002	3D7KLXCD	1998	CHEMICAL MIXTURES AND CANCER INVASION PROPERTIES	0
10	1R01ES009678-01	LAI, JAMES C	ES98-002	3D3K0XCD	1998	TOXIC MECHANISMS IN ABSORPTION OF CHEMICAL MIXTURES	0

Click publication title to bring up publication summary detail page.

Example 2- Project Search: Select Projects for Publication Search

Build a hit list of all pubs related to a group of projects



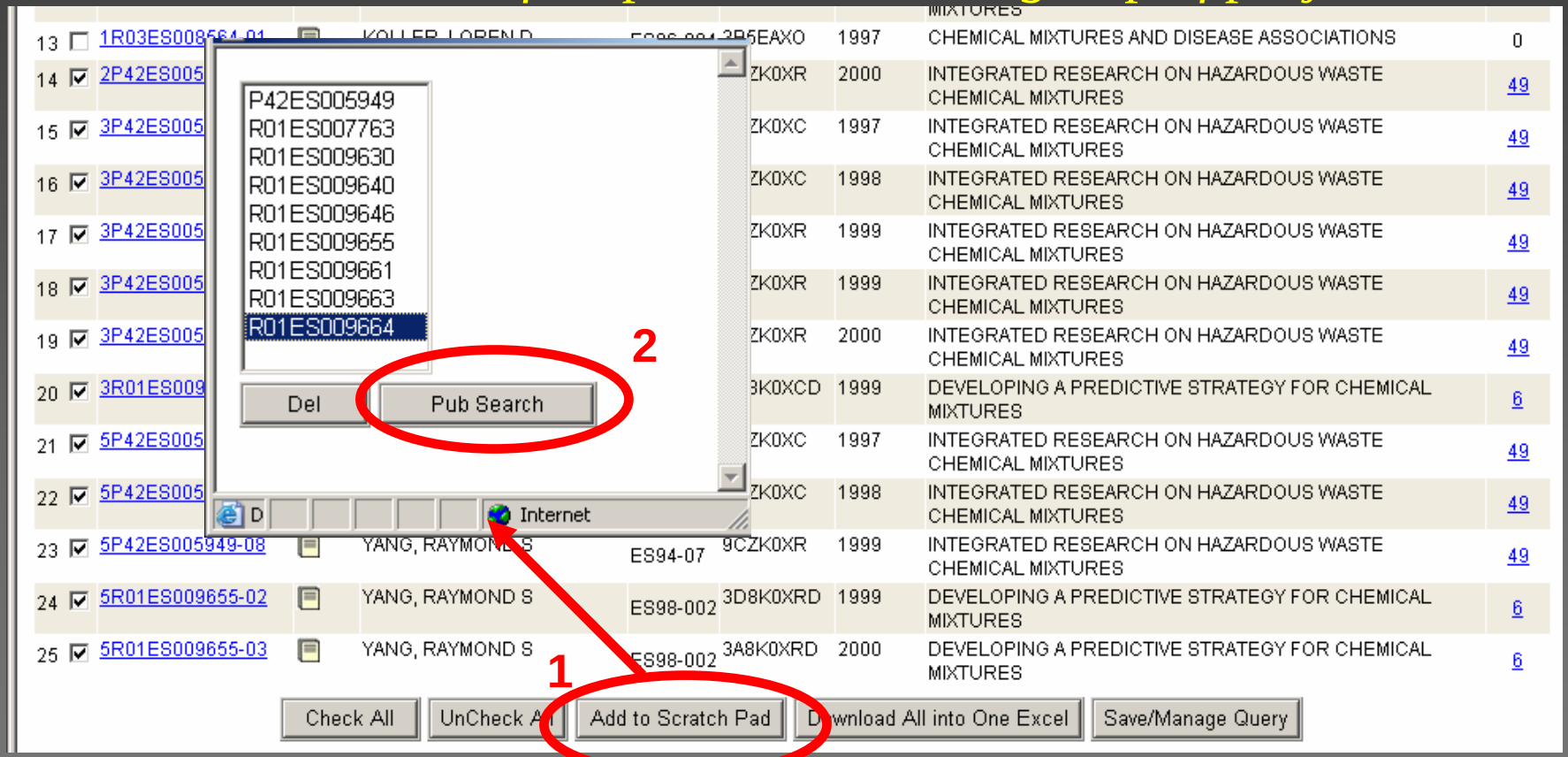
							MIXTURES	
13	☐	1R03ES008564-01	KOLLER, LOREN D	ES96-004	3B5EAXO	1997	CHEMICAL MIXTURES AND DISEASE ASSOCIATIONS	0
14	☑	2P42ES005949-09	YANG, RAYMOND S	ES99-001	9CZK0XR	2000	INTEGRATED RESEARCH ON HAZARDOUS WASTE CHEMICAL MIXTURES	49
15	☑	3P42ES005949-06S1	YANG, RAYMOND S	ES94-07	9CZK0XC	1997	INTEGRATED RESEARCH ON HAZARDOUS WASTE CHEMICAL MIXTURES	49
16	☑	3P42ES005949-06S2	YANG, RAYMOND S	ES94-07	9CZK0XC	1998	INTEGRATED RESEARCH ON HAZARDOUS WASTE CHEMICAL MIXTURES	49
17	☑	3P42ES005949-08S1	YANG, RAYMOND S	ES94-07	9CZK0XR	1999	INTEGRATED RESEARCH ON HAZARDOUS WASTE CHEMICAL MIXTURES	49
18	☑	3P42ES005949-08S2	YANG, RAYMOND S	ES94-07	9CZK0XR	1999	INTEGRATED RESEARCH ON HAZARDOUS WASTE CHEMICAL MIXTURES	49
19	☑	3P42ES005949-08S3	YANG, RAYMOND S	ES94-07	9CZK0XR	2000	INTEGRATED RESEARCH ON HAZARDOUS WASTE CHEMICAL MIXTURES	49
20	☑	3R01ES009655-01S1	YANG, RAYMOND S	ES98-002	3D8K0XCD	1999	DEVELOPING A PREDICTIVE STRATEGY FOR CHEMICAL MIXTURES	6
21	☑	5P42ES005949-06	YANG, RAYMOND S	ES94-07	9CZK0XC	1997	INTEGRATED RESEARCH ON HAZARDOUS WASTE CHEMICAL MIXTURES	49
22	☑	5P42ES005949-07	YANG, RAYMOND S	ES94-07	9CZK0XC	1998	INTEGRATED RESEARCH ON HAZARDOUS WASTE CHEMICAL MIXTURES	49
23	☑	5P42ES005949-08	YANG, RAYMOND S	ES94-07	9CZK0XR	1999	INTEGRATED RESEARCH ON HAZARDOUS WASTE CHEMICAL MIXTURES	49
24	☑	5R01ES009655-02	YANG, RAYMOND S	ES98-002	3D8K0XRD	1999	DEVELOPING A PREDICTIVE STRATEGY FOR CHEMICAL MIXTURES	6
25	☑	5R01ES009655-03	YANG, RAYMOND S	ES98-002	3A8K0XRD	2000	DEVELOPING A PREDICTIVE STRATEGY FOR CHEMICAL MIXTURES	6

Check All | UnCheck All | Add to Scratch Pad | Download All into One Excel | Save/Manage Query

1. *Select projects for next pub search via check boxes*
2. Click Add to Scratch Pad

Example 2- Project Search: Select Projects for Publication Search

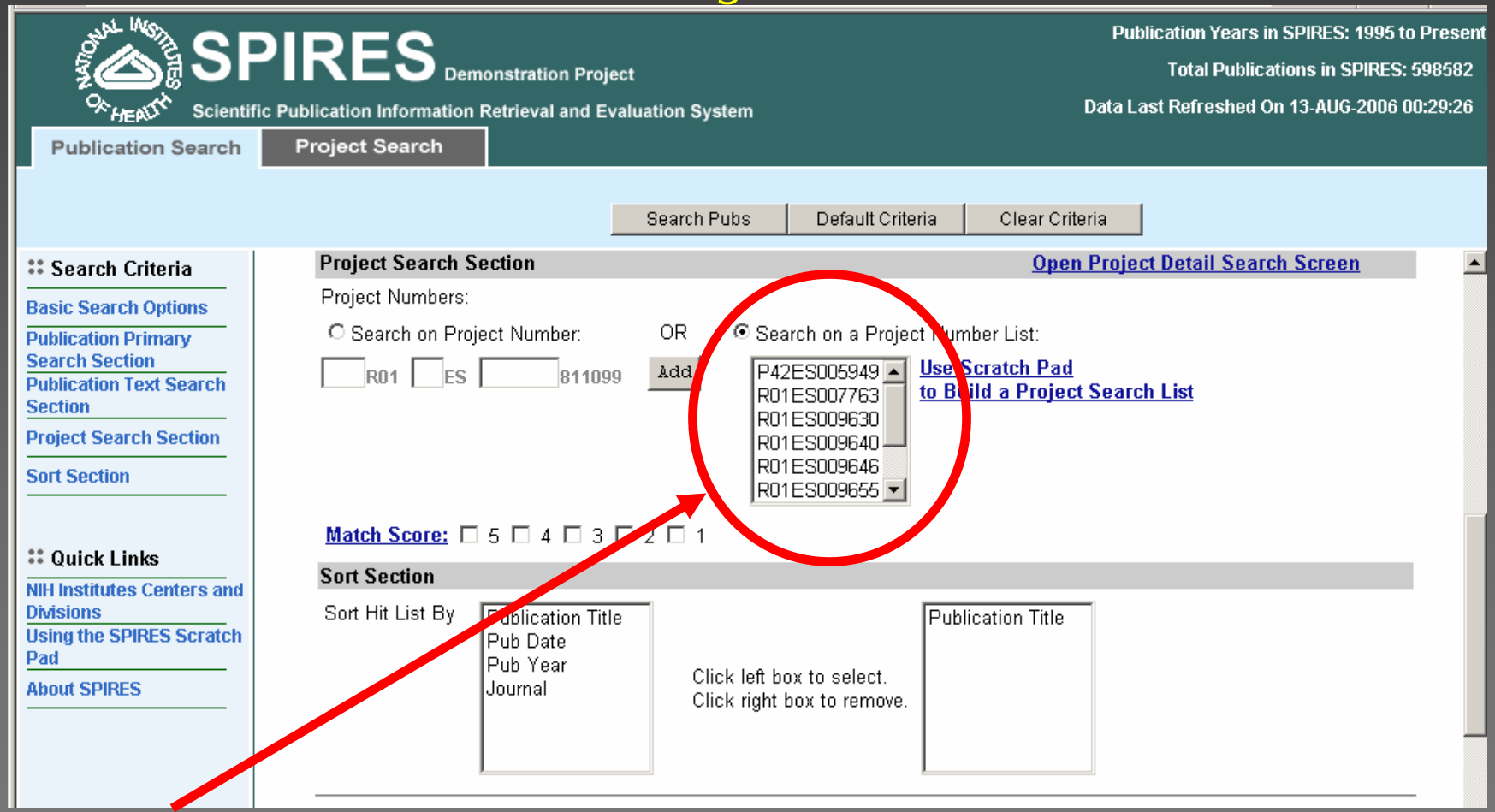
Build a hit list of all pubs related to a group of projects



1. Select projects for pub search via check boxes
2. *Click Add to Scratch Pad(1), then press Pub Search(2)*

Example 2- Project Search:

Selected Projects Automatically Transferred to Pub Search Screen Using Scratch Pad

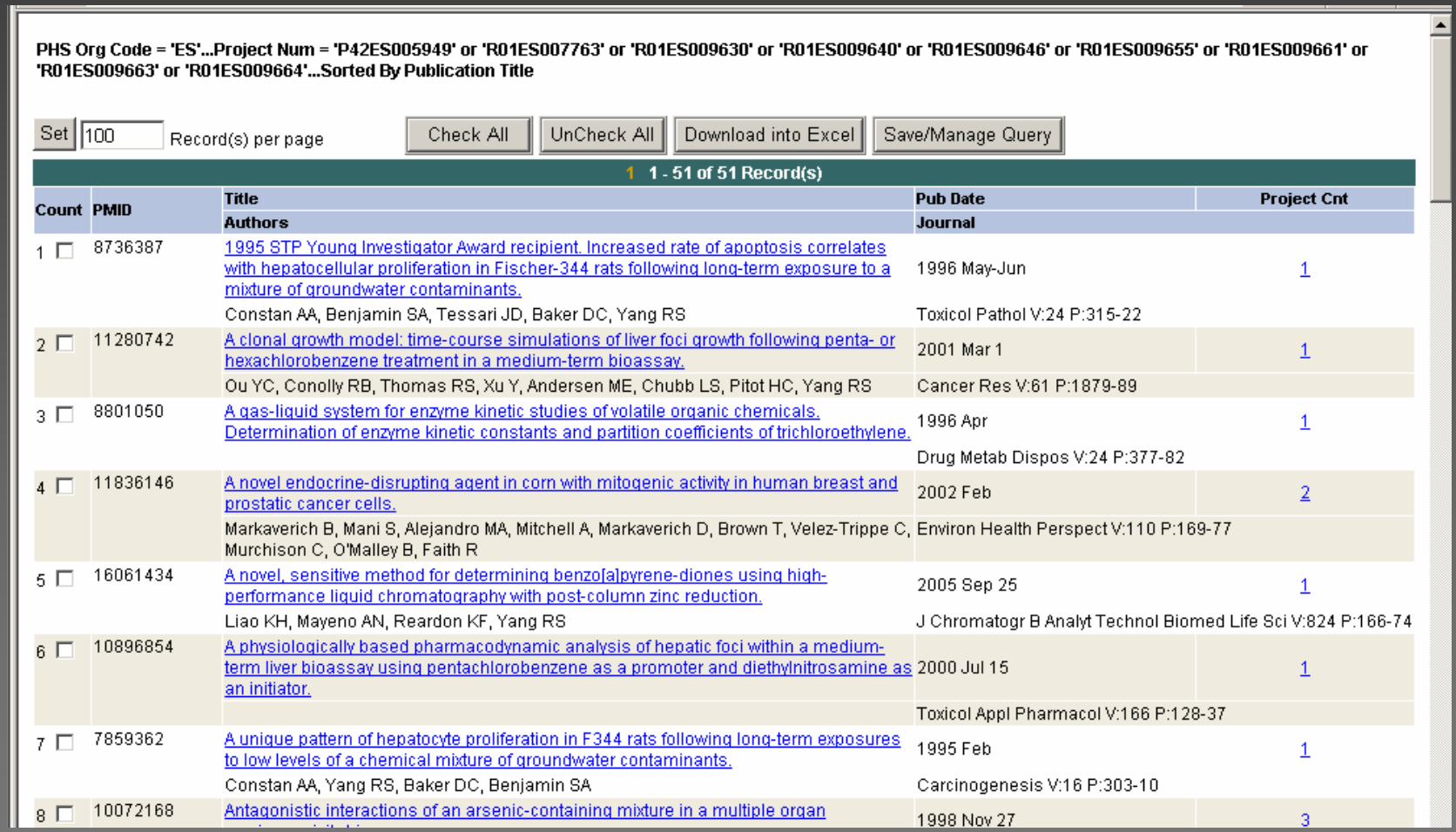


--Project List was automatically transferred to pub search from scratch pad

--Simply press Search Pubs to get pub hit list for these projects.

Example 2- Project Search:

Publication Search Result Page (After Using Scratch Pad)



PHS Org Code = 'ES'...Project Num = 'P42ES005949' or 'R01ES007763' or 'R01ES009630' or 'R01ES009640' or 'R01ES009646' or 'R01ES009655' or 'R01ES009661' or 'R01ES009663' or 'R01ES009664'...Sorted By Publication Title

Set 100 Record(s) per page | Check All | UnCheck All | Download into Excel | Save/Manage Query

1 1 - 51 of 51 Record(s)

Count	PMID	Title / Authors	Pub Date / Journal	Project Cnt
1	8736387	1995 STP Young Investigator Award recipient. Increased rate of apoptosis correlates with hepatocellular proliferation in Fischer-344 rats following long-term exposure to a mixture of groundwater contaminants. Constan AA, Benjamin SA, Tessari JD, Baker DC, Yang RS	1996 May-Jun Toxicol Pathol V:24 P:315-22	1
2	11280742	A clonal growth model: time-course simulations of liver foci growth following penta- or hexachlorobenzene treatment in a medium-term bioassay. Ou YC, Conolly RB, Thomas RS, Xu Y, Andersen ME, Chubb LS, Pitot HC, Yang RS	2001 Mar 1 Cancer Res V:61 P:1879-89	1
3	8801050	A gas-liquid system for enzyme kinetic studies of volatile organic chemicals. Determination of enzyme kinetic constants and partition coefficients of trichloroethylene. 	1996 Apr Drug Metab Dispos V:24 P:377-82	1
4	11836146	A novel endocrine-disrupting agent in corn with mitogenic activity in human breast and prostatic cancer cells. Markaverich B, Mani S, Alejandro MA, Mitchell A, Markaverich D, Brown T, Velez-Trippe C, Murchison C, O'Malley B, Faith R	2002 Feb Environ Health Perspect V:110 P:169-77	2
5	16061434	A novel, sensitive method for determining benzo[a]pyrene-diones using high-performance liquid chromatography with post-column zinc reduction. Liao KH, Mayeno AN, Reardon KF, Yang RS	2005 Sep 25 J Chromatogr B Analyt Technol Biomed Life Sci V:824 P:166-74	1
6	10896854	A physiologically based pharmacodynamic analysis of hepatic foci within a medium-term liver bioassay using pentachlorobenzene as a promoter and diethylnitrosamine as an initiator. 	2000 Jul 15 Toxicol Appl Pharmacol V:166 P:128-37	1
7	7859362	A unique pattern of hepatocyte proliferation in F344 rats following long-term exposures to low levels of a chemical mixture of groundwater contaminants. Constan AA, Yang RS, Baker DC, Benjamin SA	1995 Feb Carcinogenesis V:16 P:303-10	1
8	10072168	Antagonistic interactions of an arsenic-containing mixture in a multiple organ	1998 Nov 27	3

On any pub search results screen, select projects for inclusion in a spreadsheet download.